POWER

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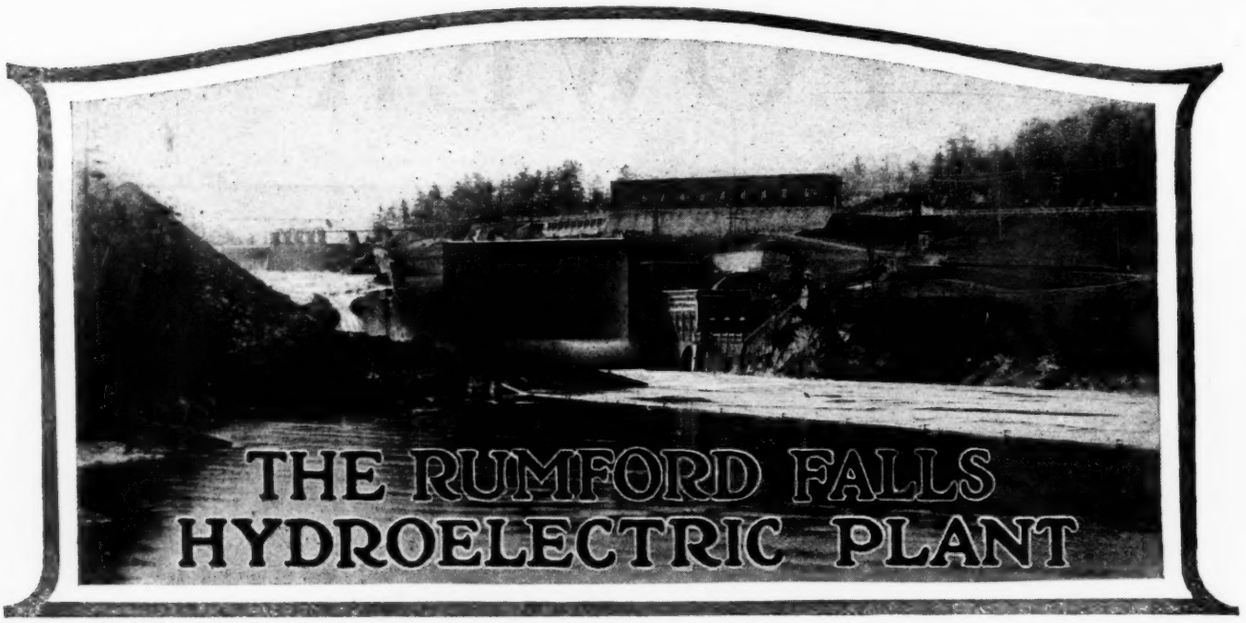


THE RUMFORD FALLS HYDROELECTRIC PLANT

The hydro-electric station atop one of the many hills of Rumford is the largest of Maine's water-power developments; its ultimate capacity is 40,000 kw. It is the fourth plant erected on the same site since 1892. Nearly all present output is consumed within 6000 ft. of the station. There are no ice troubles here. Immense storage is afforded by the famous Rangeley Lakes.

IN 1892 the City of Rumford, Me., was a wooded island in the Androscoggin River. Today it boasts 10,000 population, is growing apace and has one of the finest residential parks in New England. The whole is the outcome of two factors—the near-by fall of the Androscoggin and the enterprise of the late Hugh J. Chisholm, Sr. The story of Chisholm and Rumford is one of absorbing interest, which, unfortunately, lack of space here forbids; but the engineering details of the power plant, which made Rumford possible, are no less absorbing. These are the subject of the present article.

The Androscoggin is one of the six large rivers of Maine, and rises in Parmachenee Lake, and the Rangeley Lakes system, which are nearly on the border of the most northeastern part of New Hampshire, where that state and Maine join. The river flows south-southwest, entering New Hampshire a few miles above Umbagog Lake, turning southwest at a point directly east of Crystal, N. H., and describing an arc between this point and Berlin Falls. It turns at right angles here, flowing east, again entering Maine just east of Shelburne, N. H., and directly west of West Bethel, Me. From Bethel to Mexico, a suburb of Rumford, it flows northeast, then southeast to Walkers, northeast to Riley, directly south to Auburn, then southeast to Brunswick, where it empties into the Atlantic.

The Androscoggin River basin above the plant at Rumford Falls has an area of 9388 square miles. Excellent storage is afforded by the Rangeley Lakes, of which there are five—seven if Pharmachenee and Umbagog are included, as they should be, for all empty into the river. The present storage capacity above Errol Dam, which is at the outlet of Umbagog Lake, the lowest of the system, is about 29.5 billion cubic feet, 9.6 billion cubic feet of which is from the Aziscohos Reservoir; 8 billion cubic feet additional may be had at an estimated total cost of $200,000. By means of the dams at the lakes the natural level in one was raised 4 ft. and in another 12 ft., 20 ft. in another, and 45 ft. in another. Rangeley, the uppermost of the system, is at an elevation of 1500 ft. above the sea. When more fully utilized, the Androscoggin will yield over 160,000 hp., of which 120,000 is developed. All present developments represent a total cost of $14,000,000.

Rumford Falls is a series of three rapids extending over about one mile and having a total drop of 180 ft. The first drop is 100 ft., used by the plant that is the subject of this article; the second drop, 50 ft., used on wheels in the mills of the International Paper Co.; the third, 30 ft., developed mechanically by the Oxford Paper Co. Water does not back up in the tailrace as at many plants during high water or high station load, because it is taken from one canal and discharged into another canal.

New Power House of Large Capacity

The new power house, Figs. 1 to 8, now built and capable of extension, will have an ultimate capacity of 40,000 kw. in five vertical units of 8000 kw. each. A new concrete dam 480 ft. long and 50 ft. high has been built. The dam and power house are shown in the headpiece. Water comes to the gatehouse through a concrete and ledge canal 100 ft. wide and 15 ft. deep. The spillway capacity is capable of passing the maximum flood of 55,000 sec. ft. Four sluice gates, power and hand operated, are reached from a girder and slab bridge. The racks at the gatehouse are two in number, the outer having bars 5 in. apart to throw off the large floating substances, the inner with bars 2½ in. apart. Trash-discharge flumes are provided. The interior of the gatehouse is shown in Fig. 5.

It was a difficult job to build the new station without interrupting operation of the old plant. To accomplish this it was advisable to bore tunnels from the headworks or gatehouse to the turbines, as new canals to carry water to the machines would have to cross the penstocks of the old machines. The tunnels are in solid granite, but they are short. Two are completed and lined with reinforced concrete, a third is bored through but not lined, and two more have been started,

borings having been made at both ends of each. The headwork is finished, so that the old power house may be taken out and the new one extended; the switchboard and conduits for all the future machines are already installed. The foundations are of concrete, the walls of red brick, the floors of white tile, the turbine-room interior of buff brick, the ceilings and wall panels white. See Fig. 8.

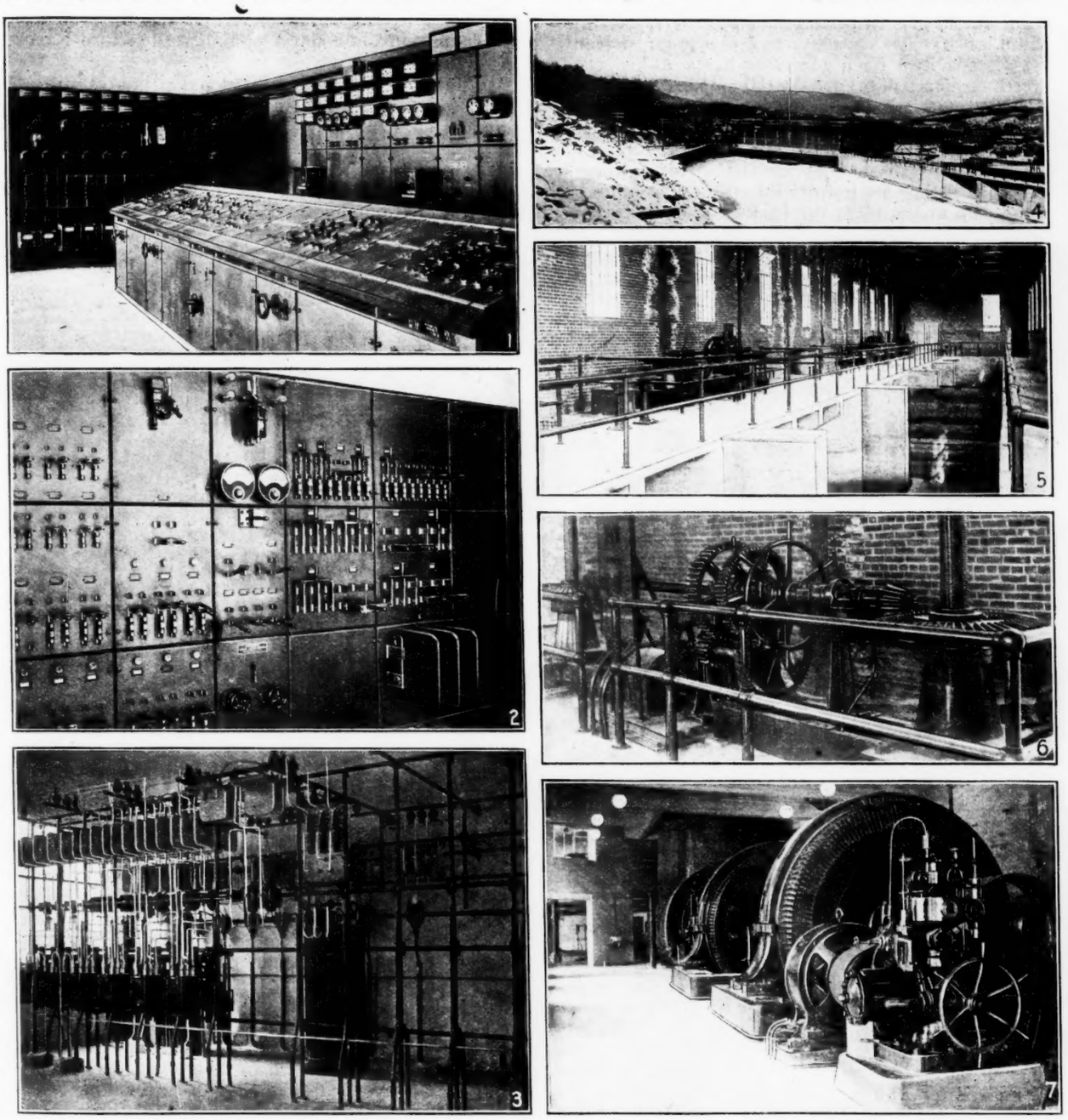


FIG. 1 TO 7. SOME VIEWS OF THE RUMFORD FALLS HYDROELECTRIC PLANT

Fig. 1—The benchboard and switchboard. Fig. 2—Station-service switchboard. Fig. 3—Some of the high-tension electrical work. Fig. 4—Looking down the intake canal toward the gatehouse. Fig. 5—Gatehouse interior. Fig. 6—Gate-operating mechanism. Fig. 7—The two units in the old station.

The old station has two 6000-hp. 400 kv.a. 2300-volt machines, Fig. 7. Each operates at 400 r.p.m. These machines are, of course, controlled from the new benchboard. Their runners are of bronze.

The new units, two of which are now in operation, are each of 10,000-hp., 8000 kv.a., 11,000-volt, 40-cycle 96 ft. head, 200 r.p.m. The turbines are of the Wellman-Seavers-Morgan type, with Lombard governors and Westinghouse generators. The runners are of cast steel, and a reserve runner is kept handy for possible breakdown. The runners and all iron parts of the machines exposed to water are painted with red lead to protect against rust. It is interesting to see how well preserved and little worn this red lead is on one of the wheels, which, when the writer saw it, had been in service many months; the metal beneath is, of course, as bright and free from corrosion as when first machined.

The governor fluid is oil, no so-called soluble oil being used; the oil pressure is 200 lb. In accordance with

modern practice the governor-pressure piping is sectionalized so that in case of breaks or serious leaks the affected section may be isolated until repairs are made, thus in no way interfering with service of the station. The system contains 5000 gal. of oil. For the two old turbines the governor pressure is individual.

The station has two independent exciters, one water-driven of 100-kw. capacity, and one motor-driven of 75-kw. capacity. Each generator has a 90-kw. exciter directly connected to it. A 150-amp.hr. storage battery is provided for emergencies. This battery automatically cuts in if the exciters happen to go dead.

At Rumford ice troubles are practically unknown. There are no provisions at the station for fighting ice of any kind; they are not needed. For eight miles back of the dam at the plant the backwater extends, covering the shallow places where frazil ice previously formed. The Androscoggin is in a cold region, and the river freezes completely over and remains frozen until the warmth of spring breaks up the ice. An open surface of river does not exist in winter, and therefore one of the essential conditions for the formation of frazil ice is never present. Surface ice, when broken and floating, is carried away from the forebay by the main stream.

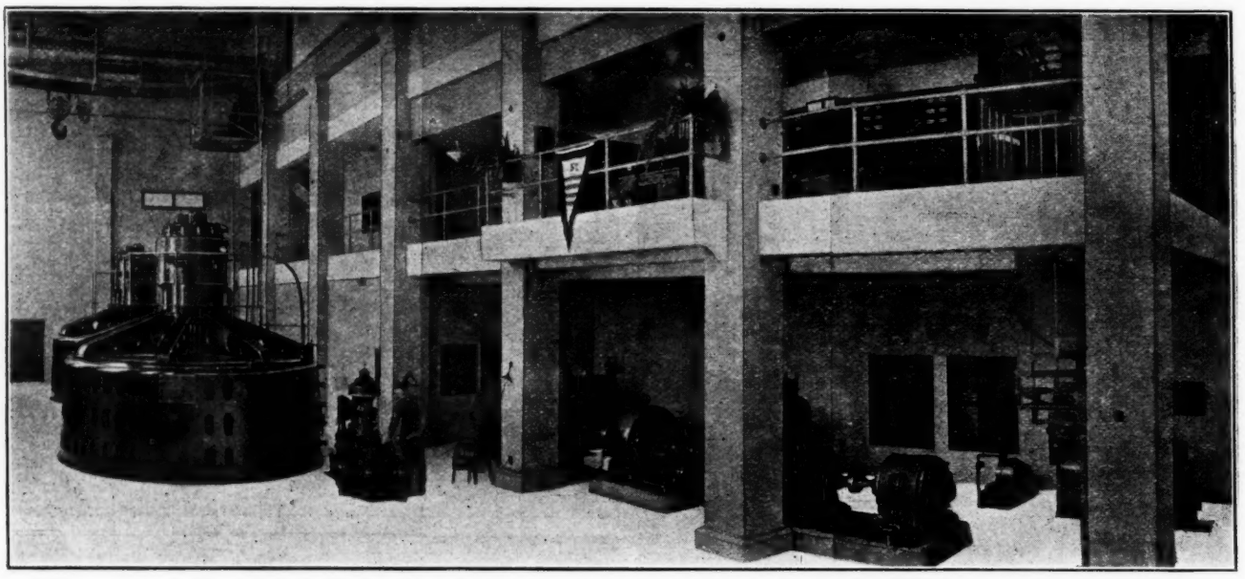


FIG. 8. VIEW INSIDE THE TURBINE ROOM, RUMFORD FALLS POWER COMPANY

The two old turbines furnish current at 2300 volts, this being stepped up to line voltage of 11,000 by Allis-Chalmers transformers. The transmission lines are fitted to carry current at 22,000 volts when the transmission distances become greater. The demand at Rumford Falls is for 24-hour power, and 90 per cent of the plant's capacity is consumed within 6000 ft. of the power station. The switchboards were built by the General Electric Co.

Hugh J. Chisholm is president of the Rumford Falls Power Co., and Charles A. Mixer is resident chief engineer in charge of hydraulic and real estate departments. C. T. Maynard is engineer in charge of the electrical department.

Cheap power and the large scale on which the Rumford Falls Power Co. has developed it will unquestionably greatly stimulate the industrial growth of Rumford. The place is already famous for its paper, and as many kinds of wood, veritable forests of it, surround the town, wood-working plants of various kinds are sure to be attracted.

Legal Aspects of Smoke Nuisances

By Arthur L. H. Street

The latest authoritative judicial determination concerning smoke as an abatable nuisance seems to have been made in the recent decision of the Georgia Supreme Court, handed down in the case of Holman vs. Athens Empire Laundry Co., 100 Southeastern Reporter, 207.

In this suit the trial judge ruled that the plaintiff, the owner of a nine-story office building in Athens, failed to make out a case for an injunction against the defendant laundry company's continued use of soft coal in operating its steam-power plant across the street in a two-story building. But, on an appeal taken by the plaintiff, the Supreme Court reversed the decision, holding that the trial judge committed an error in refusing to permit the jury to determine whether the defendant's use of soft coal under the particular circumstances constituted a nuisance.

The defendant had operated its plant for several years before the plaintiff constructed his office building, but appears to have used coke as fuel most of the time. The laundry smoke-stack is about sixty feet high, the top being on a level with the sixth story of the plaintiff's building.

The plaintiff admitted that the defendant's use of coke caused no substantial injury to his building or discomfort to his tenants, but complained that when soft coal was adopted by the defendant as a fuel, dense black smoke was blown against and into the building when the wind happened to be in that direction. Loss to the plaintiff through discoloration of the interior of the building and threatened loss of tenants were claimed.

The defense contended that coke could no longer be obtained in the local market excepting at prohibitive prices, that no more smoke was emitted than was absolutely necessary in the proper operation of the boiler, that the power plant was operated by a skilled fireman and engineer, that the plaintiff himself used soft coal in the operation of the heating and power plant in his building and caused injury and annoyance to the defendant when eddies of smoke were forced down by air currents and atmospheric conditions.

At the trial the plaintiff offered evidence tending to show that coke could be obtained at reasonable prices

and that the volume of smoke thrown from the defendant's plant could be gradually reduced and controlled by the use of modern appliances.

The following statements of law are to be gleaned from the opinion on appeal:

Where a nuisance affects the public generally, proceedings for its abatement should be brought in the name of the state, and not by one member of the public so affected. But where a nuisance, although public in nature, causes special damage to a private citizen, he may maintain an injunction suit in his own name. And it is found that plaintiff's evidence justified the bringing of suit by him.

Theoretically, every person has the natural right to have the air diffused over his premises in its natural state, free from all artificial impurities. . . . If this rule were literally applied, its application would seriously disturb business, commerce and society itself. Hence, by air in its natural state and free from artificial impurities is meant pure air consistent with the locality and the nature of the community. . . . The use of fuel in the home, the place of business and the manufacturing establishment is necessary. In proportion as the population thickens, the impurities thrown into the air are increased. The pollution of the air, actually necessary to the reasonable enjoyment of life and indispensable to the progress of society, is not actionable; but the right (and such it must be conceded) must not be exercised in an unreasonable manner so as to inflict injury upon another unnecessarily. . . .

Smoke is not in itself a nuisance. . . . To constitute smoke a nuisance, according to the authorities, it must be such as to produce a visible, tangible and appreciable injury to property or such as to render it specially uncomfortable or inconvenient or materially interfere with the ordinary comfort of human existence. . . .

That the business itself is offensive to others or that property in the neighborhood of such business is necessarily adversely affected thereby, or that persons of fastidious taste would prefer its removal is not sufficient. Applying the foregoing principles to the case in hand, the defendant may make use of its property and carry on any business, not in itself a nuisance, that produces no unnecessary, unreasonable, unusual or extraordinary impregnation of the air with smoke or soot, to the sensible inconvenience and discomfort of the plaintiff's tenants or to the actual, tangible and substantial injury of the plaintif's realty. Whether a nuisance in fact existed, in the circumstances of this case, was at least a question for the jury.

In the course of the discussion the Supreme Court refers to a decision of the Tennessee Supreme Court, handed down in the case of Union Planters' Bank and Trust Co. vs. Memphis Hotel Co., 139 Southwestern Reporter, 715. In that case, which arose in Memphis, the Tennessee court refused to grant an injunction which in effect would have required a fifty-foot extension of a smoke-stack to avoid smoke blowing into the windows of a fifteen-story building. The court took the view that it would be inequitable to require the owners of established steam-power plants in the hearts of populous cities to keep on extending the stacks to meet the convenience of occupants of buildings near-by of increasing height, noting that if that principle were adopted the defendant might in time be required to adjust its smoke-stack so as to discharge the smoke at a level above the top of a thirty-story or even higher building.

But the Georgia court distinguishes this decision as a precedent for a holding in the case in hand, on the ground that in the Tennessee case it was not claimed that the defendant could avoid annoyance to occupants of the plaintiff's building by any substitution of fuel.

The two courts seem to take divergent views on one point—the effect of a complaining person's use of the same kind of fuel that he objects to being used by a neighbor. The Tennessee court suggested that had plaintiff in the Memphis case objected to defendant's use of soft coal, the objection would not have been considered because plaintiff itself used that kind of coal. On the other hand, the Georgia court holds that a plaintiff is not necessarily precluded, intimating that the defendant's remedy is to seek such an injunction against the plaintiff as the latter seeks against him. A decision of the Michigan Supreme Court is cited as supporting this latter view.

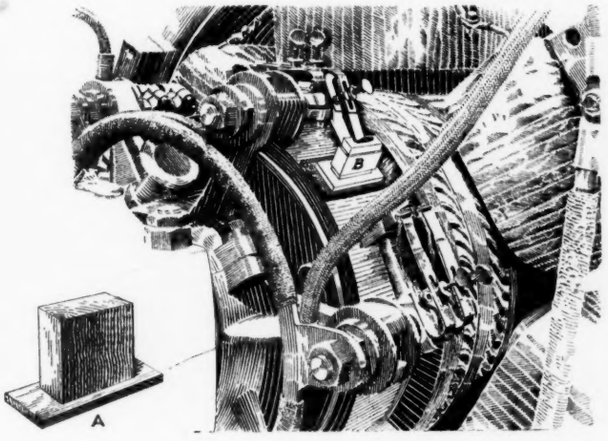
Concluding its opinion, the Georgia Supreme Court says:

Equity is asked to do no more than to restrain the defendant from using soft coal, that is, "such coal as throws out a black, dense smoke," and the evidence in the record is such as to authorize a finding by the jury that the use of coke was at once convenient and practical. The court is not asked to abate the defendant's laundry. If a case be otherwise made out, injunctive relief cannot be denied the plaintiff, although the nuisance results from smoke alone.

Preventing Sparking at Commutators on Slow Speed Machines

By B. A. Briggs

On slow-speed direct-current machines the peripheral velocity of the commutator is not high enough to throw off, by centrifugal force, the small particles of dust and dirt that may collect on the commutator surface; consequently, there is always more or less sparking due to the particles of dirt causing minute arcs across the mica insulation. Although these arcs may not cause serious



CLEANING BRUSH IN POSITION ON COMMUTATOR

trouble, they are not the most pleasant things for the maintenance man to look at, especially when the moderate- and high-speed machines are operating sparkless. Cleaning the commutator on a slow-speed machine is not very effective in relieving the sparking; although it gives temporary relief, the trouble soon appears again. The scheme illustrated in the figure is one that has proved to be very satisfactory in preventing the arcs in question. An additional brush-holder *B* is placed on one of the studs and turns in the opposite direction from the other brush-holder. In this brush-holder is placed a fiber or wooden brush, under the end of which is placed a piece of canvas three or four folds thick. The brush is made with an end considerably larger than the holder, as shown at *A*. This brings the canvas in contact with a greater area of the commutator. The canvas wipes the dirt off the commutator and prevents the pin arcs. If the commutator is of a width to warrant it, two or more of the wiping brushes may be used. The canvas will have to be turned or changed from time to time, the frequency depending upon how constantly the motor is used and upon the amount of dirt suspended in the surrounding atmosphere.

The Absorption Refrigerating Machine—I

By H. J. MACINTIRE
Professor of Mechanical Engineering, University of Idaho

THERE is a saying among salesmen for refrigerating machines that it is easier to teach a man without any idea of engineering about the care and operation of the absorption refrigerating machine than it is to get a licensed engineer to learn these things. This statement is far-fetched, and yet there is something in the remark. Perhaps it is that the absorption machine is a mass of valves and fittings; perhaps it is that there are no moving parts except a small pump hidden off there in the corner, or perhaps the engineer is hunting for something hard and overlooks the fact of the simplicity of this form of refrigerating machine. Be this as it may, the writer has figured the matter out for himself, and the following is his own explanation, offered to the reader in the hope that it may be of some assistance in understanding and operating this important machine.

The Compression Refrigerating Machine

Before going into the subject proper, it will be well to consider the compression refrigerating machine. The ammonia compression machine is only a pump. It takes a vapor or slightly superheated gas at a nominal pressure and increases the pressure some six or twelve times, enough so that when the compressed gas is cooled by water from a well or river or pond, it will be condensed. Now, in steam-economy practice we always speak of the water rate of a steam engine, meaning the number of pounds of steam per hour used to obtain one horsepower for the same hour. Likewise, in refrigeration the amount of refrigeration is dependent on or proportional to the weight (or number of pounds) of ammonia compressed and evaporated per hour. A 9 x 9-in. single-acting compressor (two-cylinder) operated at 140 r.p.m. will perform a duty at the rate of 20 tons of refrigeration per 24 hours under standard conditions (zero degrees boiling temperature of ammonia), but it will be 25 tons with a higher back pressure (suction pressure) and 15 tons at a lower back pressure. The reason for this is that the refrigerating duty is proportional to the weight of ammonia taken into the cylinder and is not dependent on the piston displacement (which was the same in each of the three cases mentioned). In other words, the volume occupied by a pound of dry, saturated ammonia is always the same for a particular pressure but is different for different pressures, being greater at low pressures. In consequence, the greatest weight is taken into the compressor cylinder when the suction pressure is highest, and therefore the tonnage must also be greatest. The compressor, then, is only a pump, which simply compresses the gas to a point where it can be condensed into liquid ammonia. Now, how about the absorption apparatus?

The absorption machine is different and yet it obtains the same results. It has to increase the pressure to the same amount if the ammonia from the expansion coils is to be condensed. And yet it is different because it has no pump to compress the gas. In fact, the absorption machine uses only heat to cause the increase in pressure—heat from boiler steam or exhaust steam or heat from any other source. The compressor is replaced by a distilling apparatus, more like the stills used in fractional distillation of alcohol or lighter grades of oil. This ammonia still contains a solution of ammonia and water. It must be understood that water can dissolve a certain amount of ammonia, depending on its temperature and the pressure exerted on it, and that it may be concentrated with a certain percentage of ammonia when the pressure and temperature are of a certain amount. Increasing the pressure or decreasing the temperature will enable the water to absorb more ammonia. Likewise, if a solution has its temperature raised and the pressure is kept the same, there will be a point where some ammonia will be driven off as a gas.

Action of the Generator

The action of the still, or the so-called generator, is shown in Fig. 1, which represents a solution of ammonia and water (called aqua ammonia) contained in a glass tube, and all immersed in a glass of hot water. The heat taken up by the aqua drives off some ammonia gas as shown, and the aqua which remains is one of less concentration. In Fig. 2 the absorption machine is more nearly represented. The large vessel contains the aqua, which is under a pressure determined by the action of the condensers. The coils within this vessel are the steam-heating coils which keep the aqua hot and provide the necessary heat for driving off the gas into the condenser, in the same manner as in Fig. 1. As the action continues, the concentration of the aqua would become less and less and finally the ammonia gas would be entirely removed unless means could be found to keep the concentration up to full strength. But first let us see what takes place after boiling the liquid ammonia in the expansion coils.

System May Operate Direct Expansion or With Use of Brine

The gas enters the condenser as a slightly superheated vapor under pressure (similar to the action of the compression cycle) and is condensed. The condenser, receiver and expansion coils are substantially identical with those for the compression machine because the liquid ammonia is likewise identical. But there is no compressor to take the low-pressure gas from the expansion coils. The absorption refrigerating system may operate direct expansion or with the use of brine. In the latter case the expansion piping is arranged for in a so-called brine cooler. The condenser cannot condense it again into liquid ammonia unless its pressure is increased some six to twelve times. It is necessary to get this gas into the generator again. It could be pumped in as *gas*, but if that were done, we might just throw away the generator shown in Fig. 2 and use a compressor. Therefore, it is clear that some convenient and economical means must be obtained for getting the ammonia gas into the generator. This is done by dissolving the gas in water and forming a so-called strong aqua.

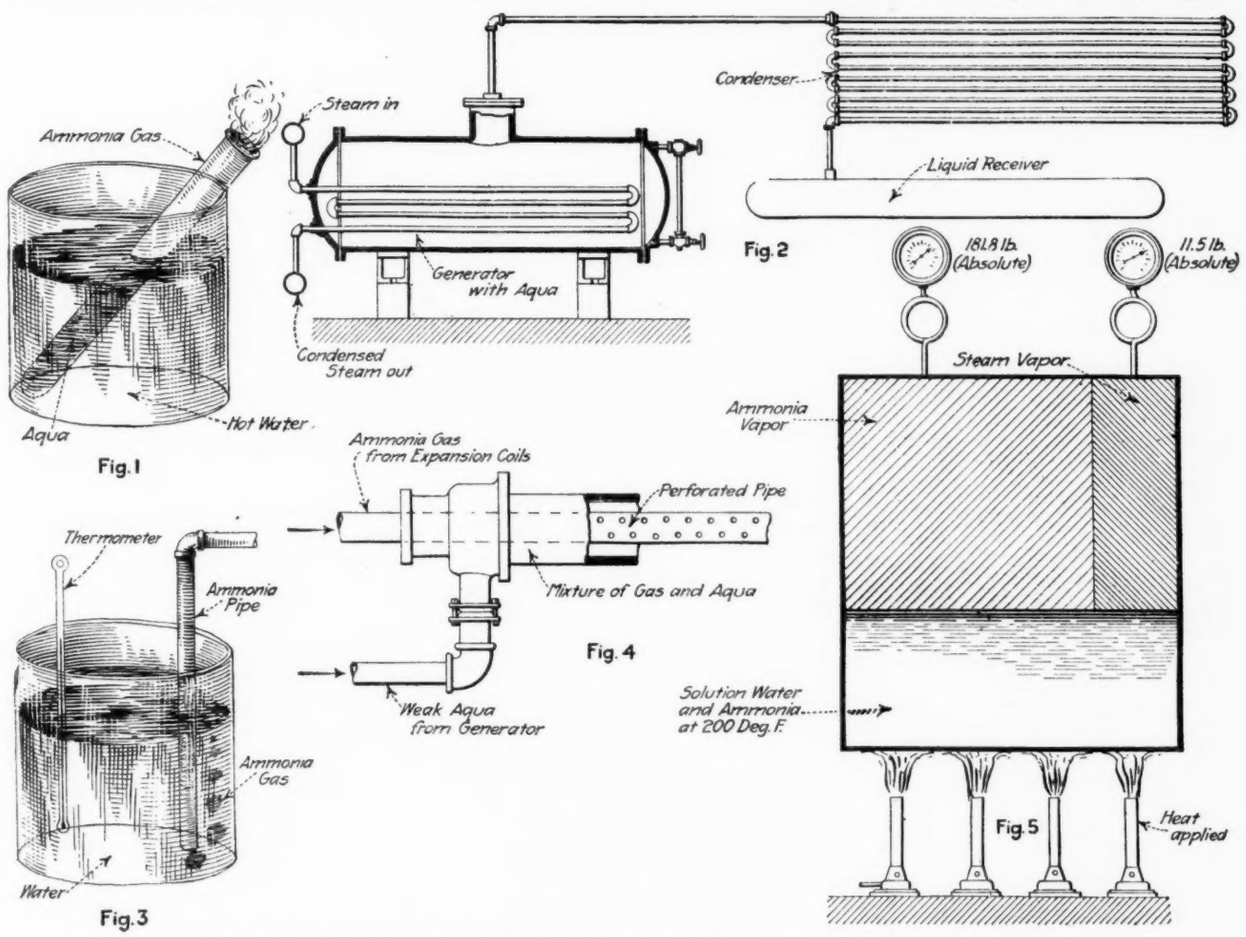
Water has a great ability for absorbing ammonia. It will dissolve several hundred times its volume of the gas. For instance, a pound of NH_3 (ammonia) at

standard pressure, 15.25 lb. gage, will occupy 9.2 cu.ft. If weak aqua of 20 per cent. concentration is brought over from the generator (that is the only water available in the absorption system) and this pound of gas is allowed to dissolve in it, say at 10 lb. gage and 90 deg. F., there would be required about 6.9 lb. of the resulting mixture to be pumped into the generator. This would occupy, roughly, 0.115 cu.ft., or about one-eightieth as much as if the gas as a gas had been compressed in a compressor under standard suction pressure. And it is evident that the size of the pump (the piston displacement required) is not affected by change of boiling temperature of the ammonia in the cooling coils. The usefulness of the absorption machine for low-temperature work is therefore self-evident.

The foregoing action can be shown by Fig. 3 where gas is allowed to bubble into a part of water. The gas is quickly dissolved so that the bubbles do not reach the top. In the absorption machine the system is a closed one, and therefore it appears more like Fig. 4, which shows the usual type of atmospheric absorber. Here the inner pipe extends part way the length of the stand and is perforated as shown. Weak aqua enters on the bottom left side and mixes with the gas, and the current carries the mixture and dissolved gas into the upper pipes. But whereas in Figs. 1 and 2, it required heat to cause the gas bubbles to occur, yet the reverse action takes place in Figs. 3 and 4 and heat is generated when the dissolving action which forms strong aqua takes place, and the thermometer shown in Fig. 3 will indicate the rise in temperature as heat is evolved during solution. However, a rise of temperature could not be allowed in Fig. 4 or a temperature soon would be obtained which would prevent further dissolving of gas. So this heat of solution is removed as promptly as it occurs by means of cooling water, shown at the right in Fig. 4.

The strong aqua pump then takes the strong aqua from the absorber at a pressure slightly higher than the boiling pressure of the ammonia in the expansion coils, and pumps it into the top of the generator, where it mixes with the aqua there. As weak aqua is heavier than strong, the solution at the bottom should be the weakest. It is customary to connect the bottom of the generator with the line going to the absorber, in order that the necessary liquid be obtained to dissolve the gas. The elementary absorption system, then, consists of a generator where the ammonia gas is driven off under condenser pressure, a condenser where the gas is condensed, a set of expansion coils where the gas is vaporized, an absorber where the gas enters a solution again, and finally an aqua pump to drive the strong aqua into the generator. The machine could work under these conditions, but not very economically.

One additional piece of apparatus required is the so-called exchanger, an apparatus required for reasons of economy. The strong aqua is cold—as cold as the water used in the absorber will allow it to be. To put cold strong aqua directly into the generator would be as unwise as to pump cold feed water into a boiler.



FIGS. 1 TO 5. ILLUSTRATING, IN ELEMENTARY WAY, THE ABSORPTION REFRIGERATION SYSTEM

Likewise, the weak aqua leaves the generator at a temperature somewhat less than the temperature of the steam used in the steam coils. It would be impossible to get satisfactory action in the absorber until the temperature of this aqua is reduced, say, to 100 deg. F. or less. Therefore, by the use of an exchanger, designed for counterflow, the strong aqua takes heat from the weak aqua, and the former is made hot while the weak aqua is cooled.

Finally, though the absorption machine would work economically with the apparatus already mentioned, it would not be practical because there would be too much steam condensed with the ammonia in the condenser, and therefore something extra is still needed. Let us consider Fig. 5, which shows what really takes place.

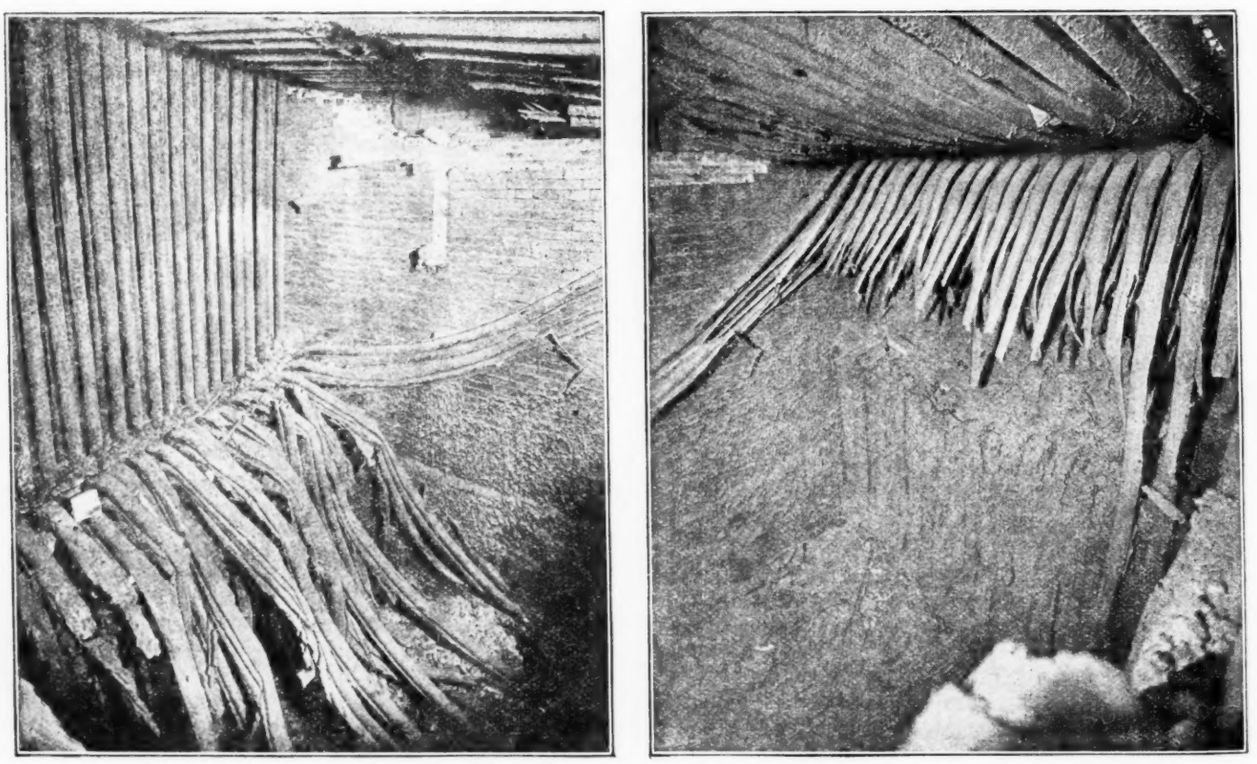
As the aqua is heated by the steam coils, its temperature finally becomes constant at, say, 200 deg. F. Assume that the condensing water cools the liquid ammonia to 80 deg. F. Then the pressure of the vapor mixture in the generator (and in the condenser) will be approximately that resulting from the sum of the partial pressures due to the vapor tension of the water vapor acting alone and the ammonia pressure acting alone. The pressure of the ammonia will be nearly that corresponding to a condensing temperature of 90 deg. F. or 181.8 lb. absolute added to the amount due to a water temperature of 200 deg., which will give an approximate steam pressure of 11.5 lb. absolute. The total pressure is about 193.3 lb. absolute, or 178.6 lb. gage.

So not only is there an increase of pressure on account of the distilling action, but steam itself will be generated (some 5 per cent.) which mixes with the superheated ammonia and passes out of the generator. If no provision was made to the contrary, the ammonia condensed in the condenser would also condense steam. As time intervened, water would accumulate and the result would be a deadening of the action of the cooling coils, requiring a lower boiling pressure to get the same boiling temperature; in fact, proper action would soon cease. So provision must be made to remove as much of the steam as is possible before letting the ammonia gas pass into the condenser.

The result is that a water-cooled rectifier or dehydrator is used to reduce the temperature of the gases passing out of the generator. This device is simply a preliminary condenser, but is operated to reduce the temperature only to within 10 to 20 deg. of the temperature of condensation of the ammonia—in this case to 100 deg. F. to 110 deg. F. The steam will be condensed almost completely, and the condensate will absorb some ammonia gas, thereby forming a strong aqua. This liquid will be caught in a separator trap and will flow by gravity back to the generator. The remaining vapor, under reduced temperature, flows into the condenser, as in the compressor machine.

To resume, the steam-heated coils cause superheated ammonia gas and steam to pass out of the generator into a water-cooled rectifier. Here the steam is condensed and is trapped off back to the generator. The anhydrous gas is condensed in the condenser, and boils into a gas again under the proper reduced pressure in the expansion coils. This gas is absorbed by precooled weak aqua from the generator at about the expansion-pipe pressure, and the resulting cold strong aqua is pumped into the generator again. Between the pump and the generator is placed the counter-current exchanger. Of the apparatus mentioned, the aqua pump is the only one which moves.

(*The second part of this article, soon to appear, will consider the operation of the absorption machine.*)



MELTED TUBES OF A WATER-TUBE BOILER THAT WAS ALLOWED TO BECOME EMPTY OF WATER

Explanation and Measurement of Maximum Demand

By

Victor H. Todd

An Explanation Is Given of What Maximum Demand Is and How It Affects the Charges for Electrical Energy. Attention Is Called to Different Types of Demand Indicators, and One Type Is Described.

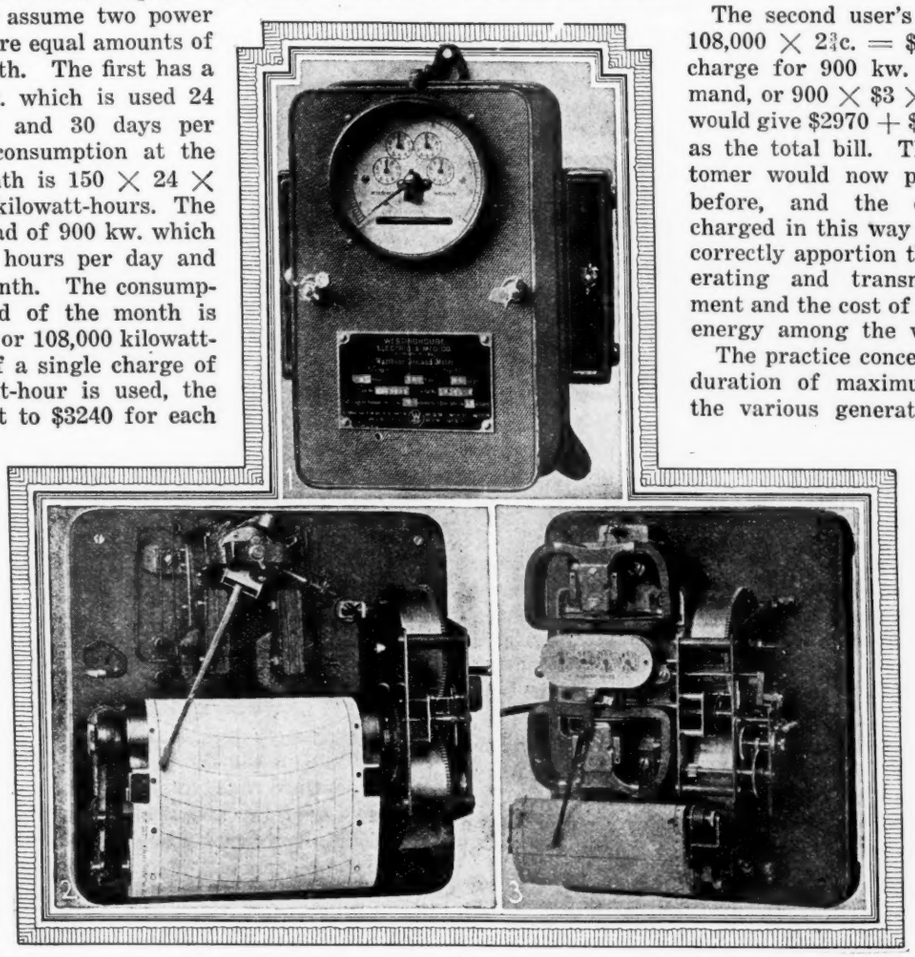
THE cost of supplying electric energy may be divided into two distinct parts—the initial cost of equipment for generating, transforming and transmitting the energy, and the cost of actually performing this work. It is therefore apparent that the user of the energy should pay for the service according to two rates—one based on the cost of equipment necessary to supply the greatest amount of energy required at any time, called the "maximum demand," and one based on the cost of each kilowatt-hour consumed.

In order to demonstrate that a single charge, based on the kilowatt-hour consumption alone may not be the most fair rate, assume two power users who require equal amounts of energy per month. The first has a load of 150 kw. which is used 24 hours per day and 30 days per month. The consumption at the end of the month is 150 × 24 × 30, or 108,000 kilowatt-hours. The second has a load of 900 kw. which is used only 6 hours per day and 20 days per month. The consumption at the end of the month is 900 × 6 × 20, or 108,000 kilowatt-hours. Now, if a single charge of 3c. per kilowatt-hour is used, the bill will amount to $3240 for each user. However, in the second case, to supply 900 kw. instead of only 150 kw., the generating company had to have larger generators, transformers and lines, with their much greater cost, and be ready to serve the user at any minute of the 24 hours, although the user's motors were idle for 18 hours per day. Apparently, this is not fair; the user should pay for this "readiness-to-serve."

Now, suppose the charge, instead of being 3c. per kilowatt-hour, was changed to 2¾c. per kilowatt-hour., with an additional charge of $3 per month for each kilowatt of the largest load taken; that is, the "Maximum Demand." In the previous examples, the first user's bill would be 108,000 × 2¾c. or $2970, plus the charge for 150 kw. maximum demand, or 150 × $3 = $450, which would give $2970 + $450 = $3420, the same as before.

The second user's bill would be 108,000 × 2¾c. = $2970, plus the charge for 900 kw. maximum demand, or 900 × $3 × $2700, which would give $2970 + $2700 = $5670, as the total bill. The second customer would now pay more than before, and the extra amount charged in this way is supposed to correctly apportion the cost of generating and transmitting equipment and the cost of generating the energy among the various users.

The practice concerning the time duration of maximum demand of the various generating companies varies over a wide range. One minute is about the minimum time for taking a maximum demand for the purposes of rate making; one hour is about the maximum time and a generally used interval. Half-hour periods are frequently used, but a shorter period than one-half



FIGS. 1 TO 3. INSTRUMENTS FOR MEASURING MAXIMUM DEMAND

hour is hardly justifiable, as there is no part of the normal generating equipment that should reach its limiting temperature in less than half an hour.

The short-time intervals are used generally to catch and discourage short-time peaks which may be eliminated by proper manipulation of load. For instance, a number of electric cranes or derricks or elevators

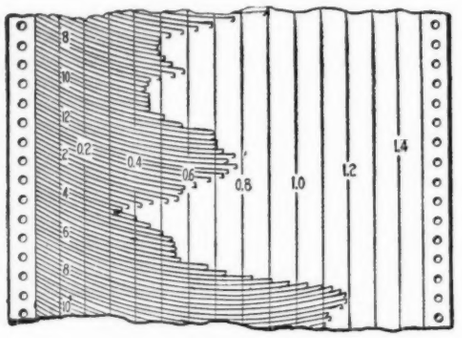


FIG. 4. FIFTEEN-MINUTE INTERVAL DEMAND-RECORD CHART

may draw a fairly steady load if operated in rotation, or at different time intervals, but if they all start at the same time, they may draw an excessive short-time load.

Off-Peak and On-Peak Demands

Realizing the ability to supply a heavy load at certain portions of the day (for instance, in the early morning hours when few lights are burning or electric cars running) and the inability to supply this load in the evening hours, some companies have separate rates for maximum demands drawn during their peak-load hours and during their off-peak hours. For instance, the power contract may read "$36 per year for each kilowatt demand used during the peak hours of 6 p.m. to 10 p.m. and $24 per year per kilowatt demand at any other portion of the day." Obviously, the result is to discourage power use during the peak-load period, thereby resulting in a more uniform 24-hour load for the generating machinery. In other cases a still lower rate is offered to fill the valley in the load curve; certain industries (for instance, ice-plants and garages, the latter charging electric cars) find it profitable to take advantage of the lower rate.

Measurement of Maximum Demand

If the installation is too small to afford a special meter, the maximum demand may be taken with an ordinary indicating wattmeter at a time when it is assumed that there is a maximum load on all the motors. This is assumed to be the maximum demand of the plant and is charged accordingly.

Another way is to take the demand direct from the watt-hour meter. To do this, observe the time required for a certain number of disk revolutions and from this figure out the demand. The formula for a meter whose disk constant is given in watt-seconds (as in a General Electric meter) is: $\textit{Watts demand} = \frac{3600 \times K \times R}{S}$, in which K equals the disk constant (generally marked on the disk), R equals the revolutions counted, and S equals the seconds for these revolutions. For instance, in a certain installation of a 15-ampere 500-volt, polyphase type D3 watt-hour meter, it was observed that 25 revolutions took 60 seconds. The constant K (marked on the disk) is 10. Therefore, working out in the formula, we get $\frac{3600 \times 10 \times 25}{60} = 14{,}166$ watts, or 14.166 kilowatts demand.

For Westinghouse meters the formula is $\frac{K \times R}{S}$ in which R and S have the same significance as before, but K is determined as follows: For all polyphase meters running at 25 r.p.m. full load $K = EI \times 4.8$, in which E and I are the volts and amperes marked on the name-plate.

Maximum Demand Meters

There are in general, six different classes of maximum-demand indicators:

1. The ampere-hour demand meter, employing the heating effect of the current to cause the air in a glass tube to expand and force a certain quantity of liquid into a suitable measuring tube. The measurement of the amount of this liquid determines the maximum demand in amperes, either alternating or direct current. This meter is now quite obsolete, although there are many still in use.

2. Watt-demand indicators such as shown in Fig. 1, employing an indicating dial, which is lagged by providing an escapement wheel and bar, which allows the indicating pointer to rise only as the disk revolutions work the escapement bar. Since the rate of escapement is proportional to the speed of the disk, and the final deflection is proportional to the watts passing through the meter, the final deflection is reached in a definite time without the use of clockwork.

3. Printing attachments to watt-hour meters, are auxiliary attachments using a circular paper disk or ribbon of paper for record. A contact on the watt-hour meter register closes at a certain number of

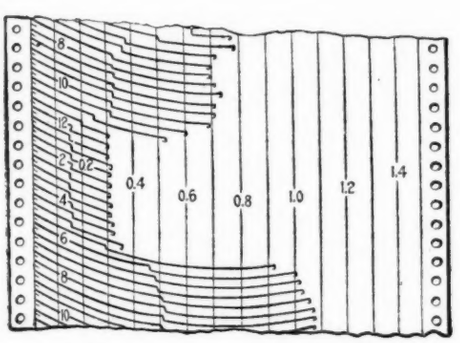


FIG. 5. THIRTY-MINUTE INTERVAL DEMAND-RECORD CHART

revolutions of the disk, and this moves a cyclometer wheel forward one number in the attachment. At stated time intervals, a clock closes a contact, which prints this number and advances the ribbon.

4. Graphic recording instruments are used extensively with these, it being merely a matter of picking out the highest point from the chart and integrating it with a planimeter.

5. Thermal-demand meters, such as shown in Fig.

2, are wattmeters actuated by the heating effect of the current, and the necessary time lag is given by providing sufficient thermal capacity to the pointer-actuating elements.

6. Combination watt-hour and demand meter, one type of which is shown in Fig. 3. This not only records the total watt-hour load, but also leaves a

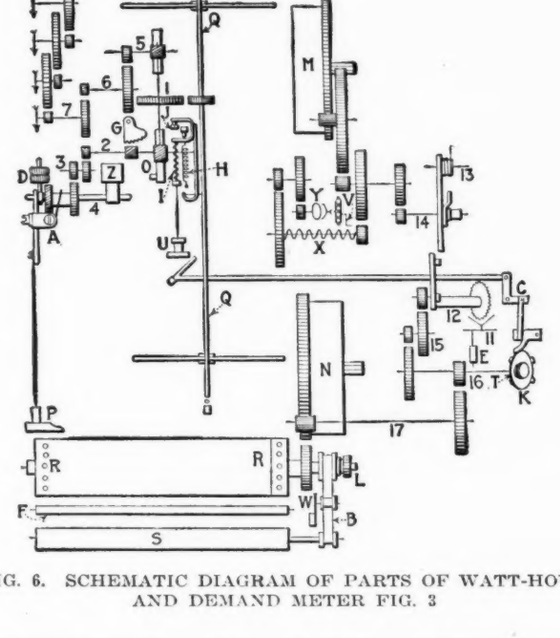


FIG. 6. SCHEMATIC DIAGRAM OF PARTS OF WATT-HOUR AND DEMAND METER FIG. 3

permanent, easily read record of the maximum demand and the time of its occurrence. The meter consists of the usual watt-hour meter element with a four-counter dial, and in addition a gear train which drives a pen across a chart at a speed proportional to the disk speed. At the end of each 15-min. interval, the clock advances the paper $\frac{1}{16}$ in., and if the meter is set to measure a 15-min. demand, it resets the pen, making a chart similar to that in Fig. 4. If set for 30-min. intervals, the advancing paper makes a little mark every 15 minutes, but the pen does not reset until the next period, thus making a chart like Fig. 5. A one-hour interval meter would have three notches in the curve before resetting.

In Fig. 6 is shown the diagrammatic scheme of parts. The disk shaft *Q* registers watt-hours in the regular manner through the gearing 1, 5, 6 and 7. At the same time the pen *P* is driven by the gearing 1, 2, 3 and 4. When the clock trips, the tripping rod, pushing against *U*, moves the small pivoted framework which carries one of the bearings of shaft 2, and disengages the worm wheel of shaft 2 from the worm on shaft 1. This allows a counterweight *D* to swing the pen back to zero. When pressure on rod *U* is relieved, the spring *H* returns the worm into mesh and allows the pen to be driven forward again.

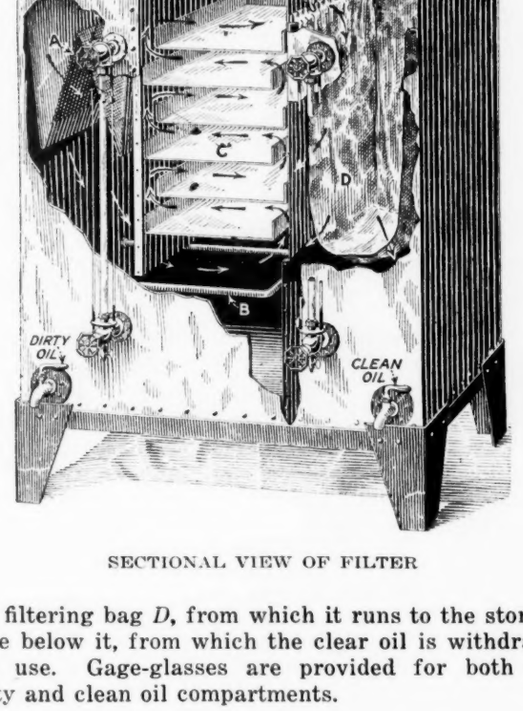
The spring *M* and the parts *X*, *Y* and *V* comprise an accurate 30-day clock. The special spring governor at *X* renders the clock isochronal. Each 15-min., the trip on shaft 14 allows 12 to rotate, power being furnished by spring *N*, and its speed is regulated by the escapement 11. This moves the paper on *R* and rotates the wheel *T* a quarter turn through shafts 15, 16 and 17. If the wheel *K* has four projections as shown, it will operate the tripping rod through the crank *C* at every trip, thus indicating the maximum demand at 15-min. intervals. If the wheel has only two projections, it will operate this rod every second time the clock trips, hence indicates 30-min. intervals, and if only one, then every fourth time, or 61-min. intervals. The main roll of paper is put on spindle *F*, passes over roller *R* and is rewound on the belt-driven spool *S*.

The meter should be mounted on a firm solid support, free from moisture, fumes or excesses in temperature or vibration. It requires only a little more attention than an ordinary watt-hour meter and gives very satisfactory results when used intelligently.

Bowser "Seven F" Oil Filter

In the Bowser filter no waste, bone black, fuller's earth, charcoal, excelsior or water is used in filtering the oil. There are but four operations performed, and these in the following order: Screening, precipitation of water, precipitation of solids, and filtering and storing of the clarified oil.

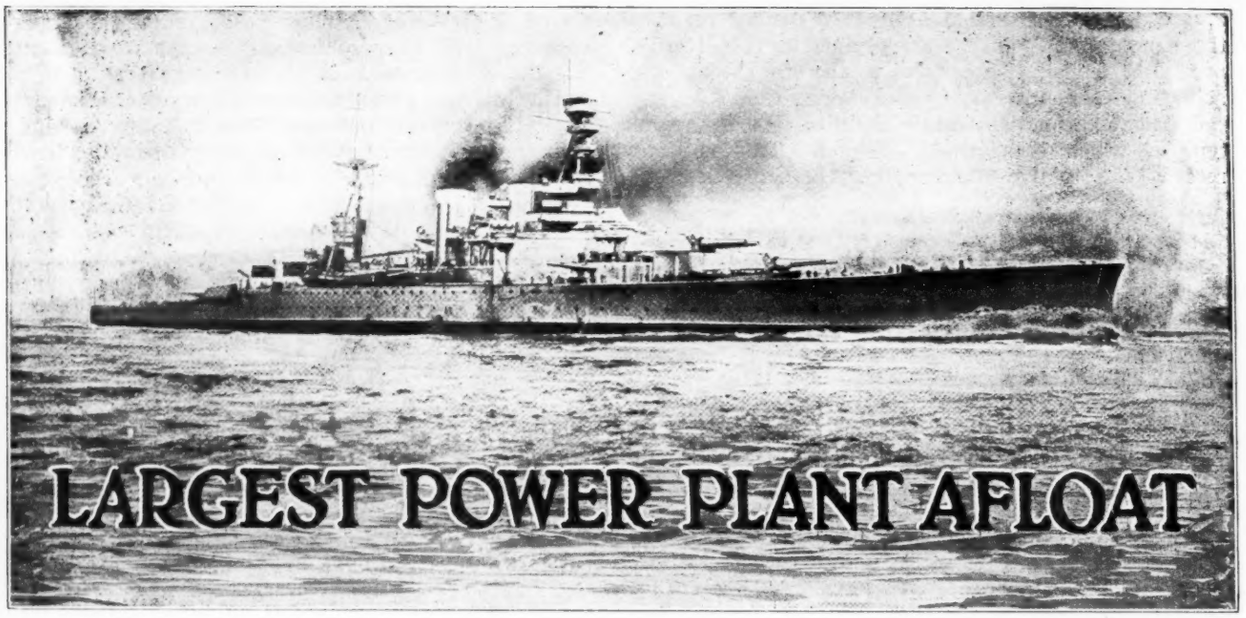
Referring to the illustration of the filter, which is made by S. F. Bowser & Co., Inc., Fort Wayne, Ind., oil is emptied into a removable strainer *A*, where pieces of foreign material are separated from it. The path of the oil is then around the steam coil *B*, up and around the precipitating tray *C*, and over into



SECTIONAL VIEW OF FILTER

the filtering bag *D*, from which it runs to the storage base below it, from which the clear oil is withdrawn for use. Gage-glasses are provided for both the dirty and clean oil compartments.

The bonus system is used in a number of power plants. In one hydro-electric plant a bonus system for the hydraulic maintenance force is in use, by which the men receive extra pay for each day that they are able to decrease the actual time a certain machine is out of service for major overhauling, as compared with the schedule time.



LARGEST POWER PLANT AFLOAT

THE British battle-cruiser "Renown," which recently steamed out of New York harbor bearing Edward, Prince of Wales, homeward bound, is the largest war vessel ever seen on this side of the Atlantic. While quietly moored for about ten days within a few hundred feet of New York's skyscrapers, and known to be one of the "hush" ships constructed for the British Navy during the world war, she was the object of much interest and speculation with respect to her appointments of size, speed, armament and power plant. The "Renown" and her sister ship, the "Repulse," constructed at the same time and designed to be alike in every respect, were the largest and most noteworthy warships added to the British fleet during the war. Ordered from the Fairfield Shipbuilding and Engineering Co., Ltd., of Glasgow, early in January, 1915, the "Renown" was completed and placed in commission in the latter part of the year 1916. Her length between perpendiculars is 750 ft.; over-all, 798 ft.; extreme breadth, 90 ft.; draft, 30 ft.; displacement, 26,500 tons, receiving power by direct-drive from Brown-Curtis turbines driving four shafts, two each side of the ship. With these turbines developing 112,000 shaft horsepower the ship has made a speed of 32.6 knots, or better than 37½ nautical miles per hour. Although this propelling power is very much less than proposed for battle-cruisers for the United States Navy, the shaft horsepower of the "Renown" renders this vessel representative of the largest-sized power plants afloat. Steam is supplied from 42 B. & W. boilers. The fuel is entirely oil, and the oil-fuel capacity of the vessel is 4259 tons, or more than 28,000 bbls., exceeding the capacity of a tank 100 ft. in diameter and 20 ft. deep.

The vessel is minutely subdivided, having six boiler rooms and a cellular double bottom extending from the middle line right around the side and under the main deck. A longitudinal bulkhead, forming the boundary of the fuel-oil tanks, extends alongside the engine rooms, boiler rooms and magazines, with an inner bulkhead forming an air space for the extent of the boiler rooms.

The vessel has a very complete equipment, although the electrical equipment is not elaborate, especially compared with our electrically-driven ships. The electric generating machinery consists of two sets of steam-driven reciprocating engines, each of 200 kw.; one turbo- and one Diesel-engine-driven generators of equal power placed in separate compartments, forward and aft. There are electric ventilating fans for machinery spaces and for working compartments and living quarters, magazine cooling and ice-making plant; electric warmers; three sets of wireless installation; eight passenger elevators, for engine and boiler rooms, each carrying two men; electric power for driving workshop machinery; also the electric equipment in connection with fire control, telephones and alarm bells, transmission of range and training guns, danger signals, torpedo control and firing gear, and gyro-compasses. The capstan engines and cable holders are of the usual steam-driven type. Steam steering engines controlled by telemotors are placed on the after bulkhead in the engine room, and are connected up by shafting and gearing to a powerful set of screw steering gear for operation of a simple balanced rudder.

Like most British ships, this modern cruiser is not heated by steam, even the quarters that were occupied by the Prince of Wales depending mainly on stoves and fireplaces.

The Brown-Curtis propelling turbines are the largest direct-drive turbines built in the world. They are placed in two engine rooms side by side, divided by a middle line bulkhead. In each engine room are three turbines that drive two propeller shafts on the same side of the vessel, the high-pressure ahead and low-pressure ahead being on the inboard shaft and rigidly connected with each other, and the intermediate-pressure ahead turbine is on the outboard shaft. Incorporated in the same casing as the intermediate-pressure ahead turbine is a high-pressure astern turbine, and with the low-pressure ahead turbine is a low-pressure astern turbine.

The high-pressure ahead turbine consists of two wheels, each carrying three rows of blades, having a pitch-circle diameter of 10 ft. 6 in. The intermediate-pressure ahead turbine consists of two stages each of two rows of blades and a short drum of 12 rows of blades; then a second portion of two stages of two rows each; and a drum of 31 rows. The pitch circle diameter of these varies from 9 ft. 3 in. to 10 ft. The low-pressure ahead rotor consists of a drum portion of 34 rows, with a pitch-circle diameter of 12 ft. The last

blades are 26 inches in length and 1⅜ inches wide. The astern turbines consist of two stages of four rows each and a drum of six rows forming the high-pressure astern turbine, and a wheel of three rows and a drum of nine rows forming the low-pressure astern turbine. The pitch-circle diameter of the high-pressure astern turbine is 10 ft. and of the low-pressure astern, 11 ft.

The propeller thrust in each case is nearly balanced by the steam thrust arranged in the turbine, so that no main thrust block is necessary, but only a comparatively small block on each line of shafting. Each of these blocks has a thrust surface of 4370 sq. in. on 16 collars. In order to obtain this balance in the intermediate-pressure turbine, one of the latest Curtis patents was introduced, namely, to take the steam a short distance along the turbine, passing it in the forward direction, and then, by external passages, to cause the steam to reënter the turbine and to travel aft for the remainder of the length of the rotor.

The shafts are hollow. The intermediate shafting is 18½ in. in diameter with an 11-in. hole, and the propeller shafts are 24 in. in diameter with a 19-in. hole. The shafts are cased with gunmetal liners in the stern tubes and main brackets.

The condensers, two for each set of engines, are placed in two compartments immediately aft of the main engine rooms, with the eduction pipes passing through the transverse bulkhead. The surface of each condenser is 19,225 sq. ft., or a total 76,900 sq. ft. for all the condensers. In the condenser room are the main circulating pumps, two per set of main engines, the evaporators, distillers, etc.

The main air pumps are in the main engine room, so as to be under the control of the engineer of the watch. The forced lubrication pumps for the turbine bearings are also in the engine rooms, together with the necessary oil coolers, filters, etc., and the smaller forced-lubrication pumps, coolers, etc., for the shaft bearings are in the condenser rooms.

As stated, steam is supplied by 42 B. & W. type boilers. They are entirely oil-fuel fired and are operated at a working pressure of 250 lb. per sq. in. The total combustion space of the boilers is 23,310 cu. ft., and the total heating surface of all boilers is 157,200 sq. ft., or more than 3½ acres. The boilers are all alike, each of 22 sections wide, 8 ft. 1 in. between headers. The bottom tubes are each 3⅛ in. external diameter, and the remainder of the tubes 1$\frac{3}{16}$ in. external diameter. There are two smoke funnels, the forward one serving 22 boilers and after one 20 boilers. The forward funnel is 25 ft. x 16 ft. 6 in., and is higher than the after one, which is 13 ft. x 16 ft. 6 in.

The Electrical Study Course—Synchronizing Alternating-Current Generators

How to determine with lamps when single-phase, two-phase or three-phase alternators are in phase, either with the lamps dark or bright at synchronism.

IN ORDER to operate two or more alternators in parallel, it is necessary that they be of the same voltage, of the same frequency, and that they be in phase. The first of these requisites is readily determinable by means of a voltmeter. To determine the other two, several devices are employed, as explained in the article, "Methods of Synchronizing Alternating-Current Machines," Sept. 16 issue. Of these the simplest is that in which two ordinary incandescent lamps are used to indicate when the correct condition exists.

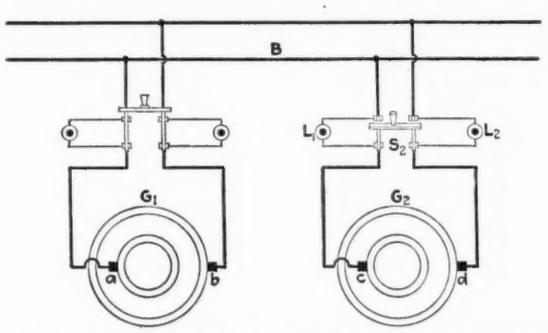


FIG. 1. CONNECTIONS FOR SYNCHRONIZING SINGLE-PHASE ALTERNATORS, LAMPS DARK

In Fig. 1 we have two single-phase alternators, G_1 and G_2. Of these G_1 is connected to the busbars B, which lead to a load. Suppose that this load increases to the point where G_1 alone cannot carry it, so that it becomes necessary to put G_2 into service also. Having started G_2 and brought it up to normal speed, its voltage is adjusted to be the same as that of the mains. At switch S_2 lamps L_1 and L_2 have been connected in the manner shown. If these lamps do not light up, it is an indication that G_2 is running at the same frequency as G_1 and in phase with it. The machines are then said to be in synchronism. It is extremely rare that this condition exists without manipulation other than that described. Ordinarily it will be found that the lamps flicker. If the two alternators are almost at the same speed the flickering of the lamps can readily be followed by the eye; they will slowly light up to full brilliancy and then as slowly dim down to complete darkness, only to light up again. This will continue with perfect regularity so long as the speeds of the generators remain exactly as they are. Any change in speed, however slight, causes a change in the intervals of brightness and darkness of the lamps.

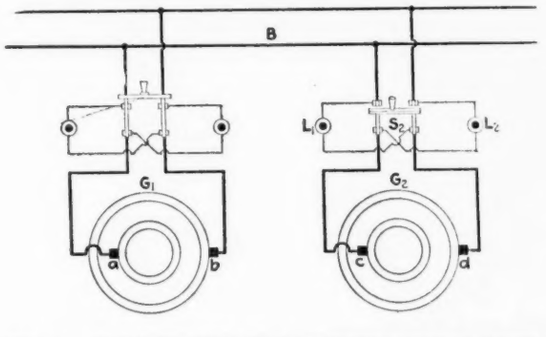


FIG. 2. CONNECTIONS FOR SYNCHRONIZING SINGLE-PHASE ALTERNATORS, LAMPS BRIGHT

Having found that the lamps flicker, the speed of G_2 is changed slightly and the effect on the lamps noted. If the flicker becomes more rapid, it is an indication that the speed has been changed in the wrong direction. If it becomes less rapid, it is known that the speed is more closely approaching that of G_1. Finally, when there is

no flicker it is proof that the two speeds are exactly the same. If the lamps are burning brightly when the flickering ceases, it is a sign that G_2 is 180 deg. out of phase with G_1 and that a short-circuit would therefore occur if S_2 were closed, even though the generators are running at the same speed. If the lamps are burning dimly, it is an indication that the machines are out of phase by some angle less than 180 deg., under which condition it is still not permissible to close S_2. When

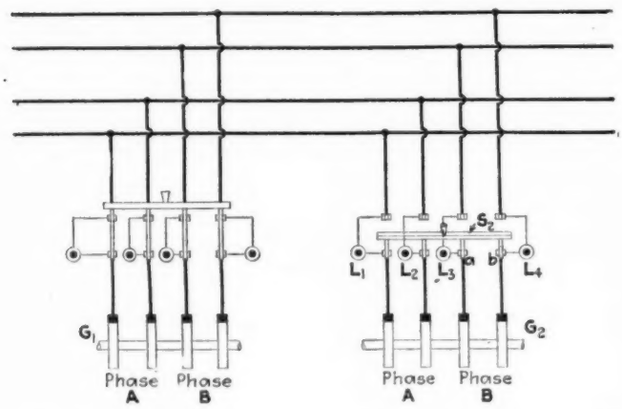


FIG. 3. CONNECTIONS FOR SYNCHRONIZING TWO-PHASE FOUR-WIRE ALTERNATORS

G_2 is in phase with G_1, the lamps remain dark. Thus, if they die down to darkness and then do not again light up, it is known that the two machines have been brought into phase and it is safe to close switch S_2, thereby connecting G_2 in parallel with G_1.

It is not usual to attempt to get the absolutely ideal condition indicated by the lamps not lighting up at all. Ordinarily, the speed adjustment is made until the lamps are flickering very slowly; that is, until it takes several seconds for the lamps to light up, dim down, and light up again. We know then that the speeds of the two machines differ only very slightly. The lamps are watched as they slowly grow dimmer and dimmer and finally become entirely dark. During this period and before they again begin to light up, the switch S_2 is closed.

Once connected to the bus B, the alternator G_2 must operate at the same frequency as that of the mains, for, as explained in the preceding lesson, alternating-current practice differs from direct-current practice, in that all the alternators connected to any one system must of necessity run at one and the same frequency. Hence, even though the speed of G_2 be slightly more or less than that of G_1, as soon as it is connected to the latter the two machines will fall into step.

Sometimes the lamps are connected as in Fig. 2; then the instant of synchronism is that at which the lamps are at full brilliancy—just the opposite from Fig. 1. This method has the advantage that if one of the lamps should happen to burn out, the fact will become manifest by the lamps refusing to light up under any manipulation of speed by the operator, and he will not be led to believe that the machines are in synchronism, as might be the case if the "dark" method were used. On the other hand, the precise instant of synchronism can be so much more readily judged in the case of the dark method, and the likelihood of an operator being deceived by the accidental burning out of a lamp is so slight that the "dark" method is in greater use than the "light" one.

The reason that the lamps in either method provide a guide is very simple. When terminal c of generator G_2, Fig. 1, is positive at the same instant as terminal a of generator G_1 and the voltage of the two machines are of the same value, then there can be no flow of current from one machine to the other, since the voltage of one machine completely neutralizes the voltage of the other so far as a circuit through the two machines is concerned. Therefore lamps L_1 and L_2 will not light up, indicating that the two machines have the same polarity. However, if terminal c is positive when terminal a is negative, then current can flow from c around to a through the armature of G_1 to b back to d and through armature G_2 to c, thus completing the circuit. It is seen from this that the same conditions exist as would if two direct-current machines of opposite polarity were connected through lamps L_1 and L_2; double potential of one machine would be applied across the lamps, and if they are for the voltage of one machine they will come up to full brilliancy, indicating, when connected as in Fig. 1, that the alternators have opposite polarity when the lamps are bright. In Fig. 2 if terminal c of G_2 is positive at the same instant as a of G_1, and the voltage of both machines is the same, then the two machines are in synchronism. However, in this case current can flow from terminal c of G_2 through L_2 around to b through G_1 to a and back through L_1 to d and through G_2 to c. Consequently, the lamps will burn bright when the machines are in synchronism.

The lamp method of synchronizing is not limited to single-phase generators, such as have so far been treated of. It is equally applicable to two-phase and three-phase synchronizing. Thus, in Fig. 3 we have two two-phase alternators, each of which has a phase A and a phase B. When the lamps L_1 and L_2 are dark, it is a sign that phase A of G_2 is in synchronism with the phase A of G_1. Similarly if L_3 and L_4 are dark the B phases are in step. It is evident that the connections must be so arranged that L_3 and L_4 are bright when L_1 and L_2 are bright and are dark when the latter are. Once the connections have been made so that such is the case, one set of lamps could be dispensed with. It is, however, preferable to keep both sets in service as a safe-

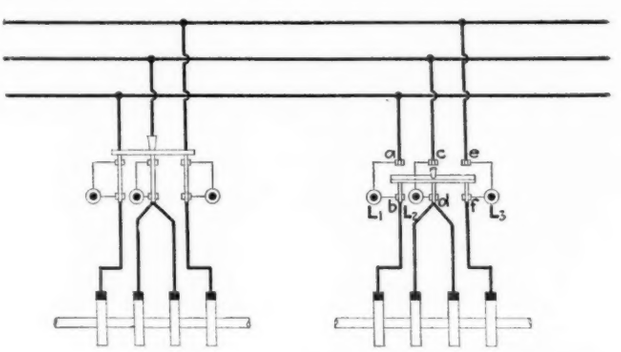


FIG. 4. CONNECTIONS FOR SYNCHRONIZING TWO-PHASE THREE-WIRE ALTERNATORS

guard. For example, the leads of phase A on G_2 might become interchanged. Lamps L_3 and L_4 would then be bright when L_1 and L_2 are dark, and vice versa, and the mistake would become evident. If, however, lamps L_3 and L_4 had been removed, there would be no indication of the interchange. Moreover, using four lamps overcomes one of the arguments against the dark method; namely, that trouble might be occasioned through lamps showing dark, owing to one being burned out. Unless one in each phase were to burn out at the same time, there would always be one phase to judge by.

In Fig. 4 are shown the connections for synchronizing two-phase generators when supplying current to a three-wire system. In this case the lamp at L_2 must be for a higher voltage than that of either phase, since the voltage across *cd* is, under normal conditions, equal to 1.41 times that across *ab* or *ef*.

The arrangement for a three-phase system is shown

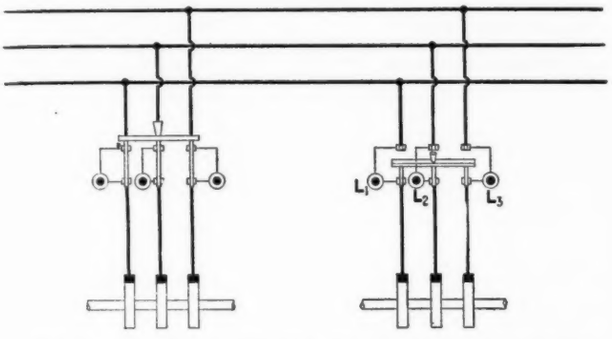


FIG. 5. CONNECTIONS FOR SYNCHRONIZING THREE-PHASE ALTERNATORS, LAMPS DARK

in Fig. 5. When correctly connected, the three lamps L_1, L_2 and L_3 will flicker in unison. If the connections have not been made correctly, it will be found that the lamps do not flicker in unison, and that as the condition of synchronism is reached, two of the lamps will be passing through a bright period while the third is passing through a dark one. Two of the leads must in that case be interchanged in order to make all three lamps indicate in unison. It is possible to synchronize three-phase generators by the use of two lamps instead of three, but the three-lamp method is preferable.

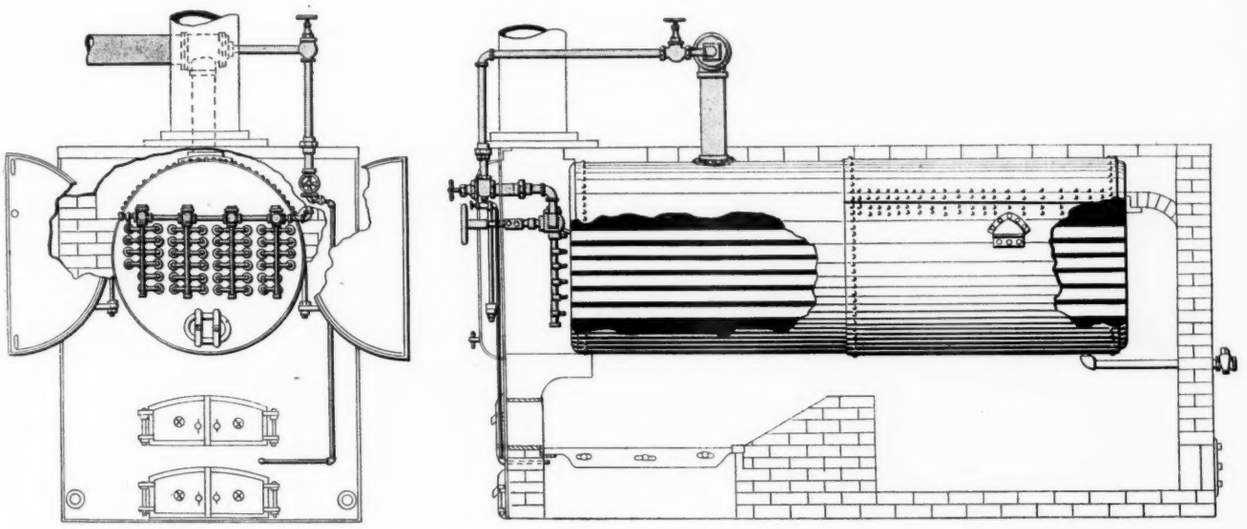
The problem of the preceding lesson stated that a polyphase wattmeter in a balanced three-phase system indicates 150 kw., that the load is connected delta and that ammeters in series with each load read 300 amperes and the voltmeters across them 220 volts. It was required to find the line current, the apparent power—that is, the kilowatt-amperes of the entire system, and its power factor. When a load is connected delta, the line current is equal to each load current times 1.73. Hence, line current $= 300 \times 1.73 = 519$ amperes. We know that apparent power in kilovolt-amperes *kv.a* $= 1.73 \times E \times I \div 1000$, where E is line voltage and I line current. Hence, we have $kv.a = 1.73 \times E \times I \div 1000 = 1.73 \times 220 \times 519 \div 1000 = 197.5$ kilovolt amperes. The power factor is equal to the actual power divided by the apparent power, hence we have,

$$Power\ Factor = \frac{kw.}{kv.a.} = \frac{150}{197.5} = 75.9\ per\ cent$$

The common wire of a three-wire two-phase system carries 141 amperes. If the load is a balanced one, what is the current in the other two wires? If the phase voltage is 115 volts, what is the apparent power? If the power factor of the load is 88 per cent., what is the actual power? If the two outside lines each have a resistance of 0.00467 ohm, what is the loss in them?

Adriance-Bate Mechanical Flue Cleaner

The Bate mechanical flue cleaner is of the fixed-nozzle type and is built and installed to meet the demands and requirements of each individual boiler. It requires less than three minutes to blow the tubes, and the stream blast is controlled by valves on the exterior of the boiler, making it unnecessary to open flue doors to clean the tubes. The cleaner, owing to its construction, acts as a superheater for the steam used in cleaning the tubes. Condensation is taken care of by ⅜-in. pipe fitted with a valve. The pressure entering the tubes passes through jets designed to create centrifugal force and high velocity. The apparatus does not interfere with the natural draft. The cleaner is removed if necessary by the disconnecting of one ground joint union without taking the cleaner apart.



ADRIANCE-BATE MECHANICAL FLUE CLEANER

The reinforced-concrete chimney, 570 ft. high and 26 ft. 3 in. inside diameter at the top, built at Saganoseki, Japan, was the subject of some investigations by Professor Omori as to the movement of the top when subject to wind pressure. Wind velocities were recorded ranging from less than one mile per hour to a hurricane velocity of 78 miles. The amplitude of vibration at a velocity of 50 miles per hour was less than one inch; at 78 miles per hour it was 7.32 in. The Maximum amplitude was in a direction at right angles to that of the wind.—*The Engineer.*

An Instrument for Measuring the Flow of Fluids

By CORNELIUS WEBER*

IN THE work of analyzing power plants and costs of energy a full knowledge is necessary of what is happening in the various pipe lines—especially the steam lines, both live and exhaust. To obtain this knowledge, steam-flow meters are pressed into service, and a graphic record, as well as a summation of the total quantity of steam flowing in a given pipe, is obtained.

The writer in his work has been confronted with the problem of steam- and other fluid-flow measurements, wherein it is necessary to take into account, not only varying pressures, but pipe characteristics as well, and where portability and adaptability to any size of pipe are of great importance, and where the instrument used may be connected or disconnected at will without interrupting the operation of the pipe in question. A careful investigation led to the conclusion that the well-known pitot tube offered a good solution, and the measuring outfit shown in Fig. 1 was designed. It consists of a universal pitot tube with a pressure gage and manometer to complete the equipment. The pitot tube itself consists of two ¼-in. brass tubes *t*, on the lower ends of which are attached the nozzles *n* shown. The brass tubes can be turned about their axes and can be moved in or out through the stuffing-boxes *b* by adjusting the

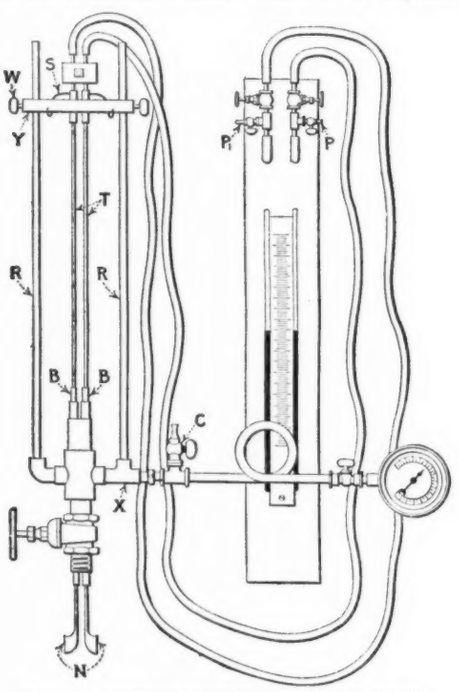


FIG. 1. INSTRUMENT FOR MEASURING FLOW OF LIQUIDS

yoke *y* up or down on the guide rods *r*, to which it can be secured by the winged nuts *w*, which serve to lock the yoke in position. Collars on the brass tubes secure the tubes to the yoke.

The upper collars have notches cut in them, into which fingers on the ends of the springs *s* fit snugly, and these serve to hold the tubes from turning about their axes when measurements are to be made. The notches in the collars are so placed that when the fingers are in these notches the nozzles point in opposite directions in order that one nozzle may point upstream and the other downstream.

When the fingers are disengaged from the notches in the collar, the tubes and nozzles can be turned and the

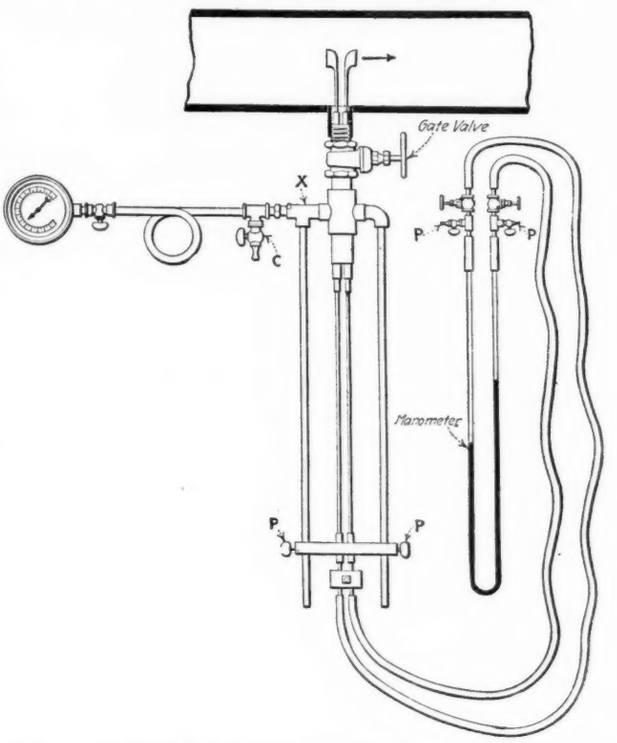


FIG. 2. DIAGRAM OF THE OUTFIT ATTACHED TO PIPE READY FOR USE

nozzles fold upon each other, allowing the latter to pass with ease through an inch pipe or gate valve. The upper ends of the brass tubes communicate through high-pressure air hose with a manometer inclosed in a wooden frame into which slits have been cut to make the two legs of the glass U-tube, inclosed within, readily visible. A differential scale, with a runner, pointer and hair line, makes accurate reading of the liquid column in the glass tubes possible.

The steam-pressure gage is attached at the point marked *x*. When meaurements are to be made, a one-inch nipple and gate valve are attached to the pipe in which it is desired to make a flow test. The pipe and gate valve are put on by the operators of the power plant, upon instructions previously issued, and must of necessity be done on Sunday or after shutdown. Several such taps in various pipes may be made for various measurements, for the instrument can be attached or detached at will.

With the nozzles folded upon each other, the instrument is screwed to the gate valve, as shown in Fig. 2. The gage and siphon are attached at *x*, and the small gage-cock *c* is opened. By means of a rubber bulb and hose, water is injected into the hose through the pet-cocks *p* until all air is expelled and solid columns of water communicate between the nozzles and the

*With Vaugh & Meyer, Milwaukee, Wisconsin.

mercury or other suitable liquid in the manometer. The various cocks are closed, and the gate valve is opened entirely. The nozzles are now pushed into the center of the stream flow and turned in such manner that one points upstream and the other downstream, whereupon the liquid column in the manometer will deflect.

The velocity of the steam or other liquid can be determined from the well-known fundamental formula, $V = \sqrt{2gh}$, where V represents velocity in feet per second, h the deflection in feet of the given substance to be measured, and g the value 32.16, the acceleration of gravity. From the velocity obtained and the density of the substance, as well as the pipe cross-sectional area,

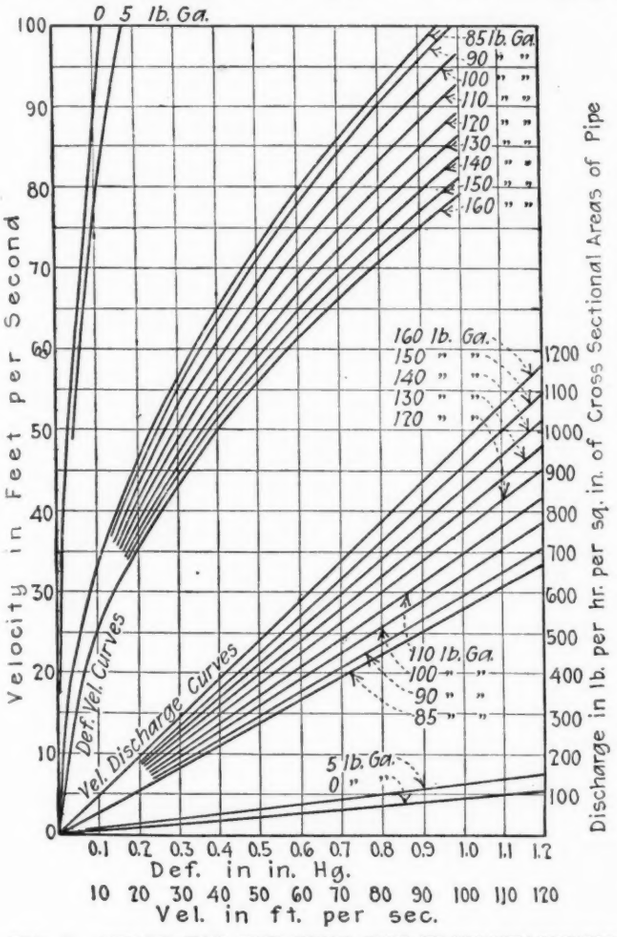


FIG. 3. CHART FOR USE WITH THE FLOW-MEASURING INSTRUMENT

the quantity flowing per hour can be determined. In a practical measurement it is, of course, necessary that readings be taken continuously, and the time, pressure and manometer reading noted whenever a change in deflection or pressure occurs. It is also necessary to make a traverse across the diameter of the pipe, to determine the ratio between the average velocity and center velocity to arrive at the pipe constant.

The instrument has been carefully calibrated by condensing and weighing the steam measured, and it was found that it has a well-defined constant of about .84; that is, the formula $V = 0.84\sqrt{2gh}$ applies to the instrument itself. Evaporation tests made on boilers, steam-consumption tests on engines, and heat balances have been made with this instrument with gratifying results.

The tedious process of calculations has been minimized through the curves developed and shown in Fig. 3. These curves have been worked out for a pipe constant of 0.9. From a given deflection and pressure reading, the velocity is found at the left, when deflection is noted at the bottom. Transposing the velocity so found at the left to the other scale at the bottom, the flow in pounds per hour per square inch of cross-sectional area is read at the right. Consulting a table of pipe sizes, the actual flow is readily determined.

As an example, let it be supposed that in a standard 5-in., pipe under 100-lb. pressure, a deflection of 0.3-in. of mercury is to be interpreted. The value 0.3 is sought at the bottom and the vertical line followed until the 100-lb. deflection-velocity curve is intersected. Reading to the left of this intersection, the value 52.5 ft. per sec. is found. Taking the value 52.5 at the bottom and following the vertical line until it intersects the 100-lb. velocity-discharge curve, it will be found by reading to the right of the point of intersection that 335 lb. of steam is flowing per hour per square inch of pipe area. Multiplying 335 by 20, the pipe area, it will be found that there is flowing 6700 lb. of steam per hour.

The instrument can be used on any size of pipe and will measure air, gas, oil or water with the same facilty with which it measures steam. The density of must, as a matter of course, always be taken into consideration.

Superheated steam at 150-lb. gage with 150-deg. of superheat has been measured with this instrument and with entire satisfaction, and the writer feels that the disadvantage of the necessity to take readings at short intervals is offset by the many other advantages that it possesses, for it can readily be carried from place to place and quickly installed. The absence of moving parts and mechanism and its general simplicity make for accuracy and reliability.

Ice Plant as Nuisance

BY A. L. H. STREET

A court decision disclosing the attitude of the courts in case where operation of a mechanical industry interferes with the enjoyment of near-by dwelling places was handed down recently by the New York Supreme Court in Brooklyn, in the case of Robb vs. Rubel Bros., Inc.

It is found that the defendant's artificial-ice plant, operated on premises adjoining the plaintiff's apartment building, resulted in reducing the value of the plaintiff's property from $12,000 to $8000. Accordingly, the court orders that unless the defendant reimburses the plaintiff against this loss, an order permanently enjoining further operation of the ice plant will be entered.

The plaintiff is held to be entitled to legal relief on a showing that the plant had been operated under such circumstances as to amount to a nuisance. The work was carried on night and day. The operation of the machinery caused constant vibration of the plaintiff's building. The handling of ice and ice tanks produced unceasing noise. Use of the ammonia condenser on the roof of the plant resulted in the projection of sprayed water against the wall of the plaintiff's building, keeping it in a constant state of dampness.

Engineer's Tool List for a New Plant

By JOHN A. STEVENS
Consulting Engineer, Lowell, Mass.

When fitting out a new power plant with tools and supplies, you are sure to leave out many things you do not want to omit. Here is a list compiled by Mr. Stevens, one of the country's well-known engineers. It is a list you will want to keep handy.

Office Equipment

One roll-top desk for engineer, medium size, sanitary base.

One small flat-top table with drawer for engineer's office.

One small bookcase or section for top of desk.

One clock in the station, Western Union connected clock preferred.

Telephone from power station, connected to the necessary departments, or switchboard of the company.

Complete engineer's log and necessary stationery.

One emergency medicinal kit.

One-gal. jar limewater and linseed oil for serious burns which the operators may receive.

Ten lb. white flour to use for burns in connection with the limewater and linseed oil.

Supply of towels and soap for engineer's lavatory, including ½ doz. cans flash or its equivalent.

Gross packages of toilet paper.

Gross of safety matches.

Pencils—black, blue, red and blue.

Box pen points.

Half-dozen pen holders.

Erasers—ink, pencil and art gum.

Inkstand.

Rulers, 15-in., flat.

Box pins.

One box each of round and oval paper fasteners.

Rubber bands.

Tube of glue.

Jar of paste.

Stationery, including envelopes.

Blotters.

One large bottle black ink.

One small bottle red ink.

Time books.

One Ever-ready electric lamp.

Instruments

Instruments located in boiler room and switchboard gallery:

Portable Orsat.

One portable steam meter with one plug each 2- to 12-in. pipe sizes.

One portable voltmeter.

One portable ammeter.

Tachometer.

Stop watch.

Barometer.

Hayes recording flue-gas apparatus.

Time clock.

One salimeter or hydrometer, if plant is located where brackish water is used.

One deadweight gage-testing equipment, complete with gage-pointer puller.

One air compressor of at least 100 ft. capacity, to deliver air at 110 or 120 lb.

Two air-pressure gages (U-gages).

One engineer's transit and level combined, and rod.

Instruments—Continued

One dozen pencil thermometers for recording temperatures from 20 deg. below zero to 750 deg. F. These in assorted temperature ranges as required.

Flue-gas thermometer.

Set of steam-engine indicators with springs, 8 to 100 lb., for each indicator if engines are used.

One 500-lb. test gage.

One 30-lb. test gage.

One vacuum-test gage.

One 250-lb. test gage.

One thousand indicator cards, if steam engines are used.

One thousand sheets for each kind of recording instrument used.

Six hanks of indicator cord.

Tools

Chisels: Complete set of flat chisels and cape chisels; complete set of carpenter's woodworking chisels and gouges.

Calking tools.

Crowbars: One 3-ft. crowbar, or spud bar; two 5-ft. crowbars; one pointed pinch bar; one flat pinch bar.

Drills: One ratchet and complete equipment of twisted drills from ½-in. to 1-in.; one breast drill with complete equipment of drills; one chain drill, hand-operated; one electric drill; one air drill and complete set of chisels; one drill press that will handle drills up to 1½-in.

Files: Two dozen assorted files, with handles for them, including all sizes of round files.

Hammers: Two machinists' hammers; two carpenters' clawhammers; two coal hammers; one 4-lb. sledge; one 20-lb. sledge; two copper or lead hammers; one blacksmiths' anvil; air hammer.

Jackscrews: One 50-ton hydraulic jack; two 8-in. common jackscrews; two 24-in. common jackscrews.

Levels: Carpenters' level and high-grade machinists' level.

Machine tools: One 15-in. engine lathe; one small shaper with the necessary cutting tools supplied; one blacksmiths' forge.

Planes: One small hand plane; one large hand plane; carpenters' draw shave.

Pliers: Three sizes of multiple lever or fulcrum pliers.

Rope: 50 ft. of ½-in. rope; 50 ft. of ¾-in. rope; 100 ft. of 1-in. rope; six balls marlin; one dozen balls strong linen string.

Rope and chain falls: One set of 3-ton chain falls; one set of 1-ton chain falls; three grab chains, made with ½-in. stock in the links with a ring in one end and a grab hook in the other 6 ft. long; one set of 4-in. blocks for inch rope; one set of 4-in. sheave rope falls for ½-in. rope; six rope slings, supplied and made ready for use, of miscellaneous lengths.

Engineer's Tool List for a New Plant—Continued

Tools—Continued

Saws: Carpenters' rip saw; crosscut saw.

Screwdrivers: Two 6-in. screwdrivers; two 12-in. screwdrivers; two 24-in. screwdrivers.

Shears: One bench-mounted shear; tinsmiths' shear.

Soldering equipment: Solder and soldering equipment for soldering irons; electric soldering iron; 25 sheets of tin; two sheets of copper; spelter, muriatic acid or other equipment.

Taps and dies: One complete set of Greenfield taps and dies, supplied in cases; one complete set of pipe dies from ¼- to 6-in., hand-operated.

Vises: One 6-in. vise; one 6-in. pipe vise; one small pipe vise that will handle pipe from ¼-in. up in the small sizes.

Wire and cable: Ten pounds copper wire, miscellaneous sizes; 50 ft. ⅝-in. wire cable.

Wire cutters: One multiple-lever wire cutter.

Wrenches: One complete set drop-forged wrenches in sizes from ⅜-in. standard nuts to 3-in.; two 6-in. monkey wrenches; two 12-in. monkey wrenches; two 24-in. monkey wrenches; two 6-in. Stillson wrenches; two 14-in. Stillson wrenches; two 36-in. Stillson wrenches; two adjustable-jaw spanner wrenches with "S" handles.

Any other special wrenches that are required to fit nuts or bolts which are in a difficult position to reach with standard wrenches (such as crow-foot wrenches or especially forged ringed spanners).

"Favorite" reversible ratchet wrenches as follows: One 15-in. handle and one head with openings for ¼-in. and ⅜-in. square nuts; one set sockets to fit head consisting of one 8-in. extension socket; ten sockets to fit standard nuts, square and hexagon, ⅜-in., 7/16-in., ½-in., ⅝-in. and ¾-in.; one extension; one drill head.

One 15-in. wrench with heads A, B and C; one 28-in. wrench with heads D, E, F, G and M.

One steel straight-edge and two other straight-edges, one 6 ft. long and one 10 ft. long (made by carpenters on the job of clear stock, dry white pine); one putty knife; one 100-ft. steel tape.

Boiler and Turbine-Room Supplies

Complete set of firing tools.

Supply of boiler handhole and manhole gaskets.

Several spare manhole and handhole yokes.

Coal supply for at least three months.

If common furnaces are used, 3 sets of furnace-door mouthpieces.

Six furnace-door liners.

Three thousand firebrick of all grades.

Two cubic yards of fine clean sand.

Dozen bags of fireclay.

Dozen bags of portland cement.

Two barrels of lime.

—— feet of air hose.

Gage glasses: One gross water-glass gage-glasses for the boilers; one dozen of all other gage-glasses used in and about the station and its equipment; gage-glass washers; washer cutter.

Masons' tools: Half dozen masons' trowels; smoothing trowel; one mortar bed.

Shovels: Dozen No. 4 scoop shovels; three square-nosed shovels; three round-nosed shovels for digging.

Packing: Ten yards "Permanite," "Durabla" or other asbestos packing; 10 yd. 1/16-in. "Rainbow"; 10 yd. ⅛-in. "Rainbow"; 2 yd. 3/32-in. "Rainbow"; 1 dozen balls "Palmetto" packing; 50 ft. each type Tuppers flax packing; 50 ft. each type flax packing from ¼-in. to ¾-in., if used in plant; 100 sets packing for condenser tubes; 2 dozen balls candle wicking; 1 set packing hooks.

Plugs: One dozen extra fusible plugs for boilers.

Tubes: Twenty-five spare condenser tubes; 20 spare tubes for the main boilers; 5 superheater tubes for the main boilers; if plunger feed pumps are used, complete set of feed-pump valves; if engines are used, spare set of crankpin boxes or crosshead boxes; one tube-boring equipment; tube expander that will expand any tube in any boiler, or 2 tube expanders, if necessary.

Miscellaneous

Half dozen sprinkler heads, high and low-pressure, if used.

Complete set of oil cans, including oil squirt cans and fillers.

Complete set of oil torches or open lamps, if station is electrically illuminated for emergency use when main current is off busbars.

Twelve sperm candles.

Two globe lanterns.

Two dozen corn brooms.

Two dusting brushes.

Square yard brass wire gauze.

One dozen galvanized iron fire pails to be used for miscellaneous work about the station.

—sheets of galvanized iron.

Bar iron: Miscellaneous bar iron, clamps and bolts from 6-in. to 10-in.; round iron from ¼-in. to 1-in., in miscellaneous lengths; ⅓ dozen lengths of bar iron from ¼ x 1 to ⅝ x 3 in., one bar each size; stock of pipe of all sizes used.

Bolts: 100 assorted bolts, nuts and washers; complete set of I-bolts, same with standard threads from ⅜ in. to 1 in.

Flanges: One pair flanges each, 2 in., 2½ in., 3 in., 4 in., 5 in., 6 in., 7 in. and 8 in. standard drilling.

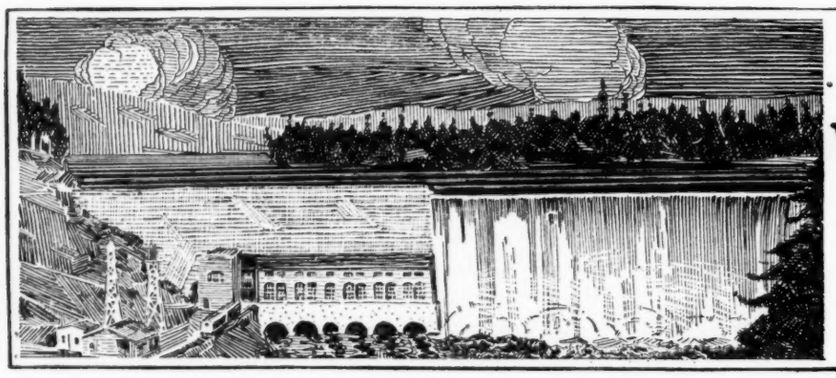
Ladders: One stepladder; one 12-ft. common ladder; one 20-ft. common ladder.

Nipples: Full assortment of pipe nipples from ¼-in. to 3-in.; close nipples and 3-in. nipples, ¼- to 3-in.

Valves: Piston rings and valve stems of every size (at least one spare valve of every size of valve used in station with the exception of feed valves, of which there should be at least two, and blowoff valves, of which there should be at least two); extra pilot valve for damper regulator, if any; extra valve disks, if this type of valve is used.

Oil: Complete supply of all oils used; barrel of kerosene oil; four 50-lb. kegs of red lead; four 50-lb. kegs of white lead; can of graphite; 5 gal. linseed oil.

Every tool and instrument stenciled, stamped or marked with the corporation's name and charged against the chief engineer upon taking charge and charged off against his account when leaving the employ and recharged to the new man entering the employ. Appraisal of this equipment taken with the main equipment each year and the stock and equipment kept up as though the equipment were a part of the main units.



POP'S WATER-POWER COURSE

By

John S. Carpenter

JIMMY waited patiently until Pop had negotiated a generous chew from his plug. "You were going to tell us what the lecturer said about finding the entrance and discharge angles and some other stunts."

"Gimme that paper an' them pencils," Pop commanded. "Now glue yer lamps to Fig. 1. This is the same wheel we've been figgerin' with at our last talk, with a ratio of 9 and a velocity percentage of 58 on the outside of the wheel. In our doin's with the Francis turbine you remember the law I gave you, the law for efficiency, 'Entrance without shock and discharge without velocity.' When we considers Pelton wheels, the law still holds good. To git the entrance angles, you lays off the velocity of the jet to any convenient scale, which is *V* in the figger. Then you does the same for the wheel velocity, only you lays it off tangent to the wheel at the place it strikes. You see that the jet particles don't strike the wheel at the same place as I shows you on sections *A*, *B*, *C* and *D*. That don't mean that the water particles has different velocities, but that they strikes the wheel at different angles. Then completin' the parryllelogram, you gits the direction of the relative velocity of the water. Now, as I told you when we was tryin' to git the angles for the Francis turbine the water must follow that relative direction or they is shock. In the sketch I shows them angles with respect to the radial line.

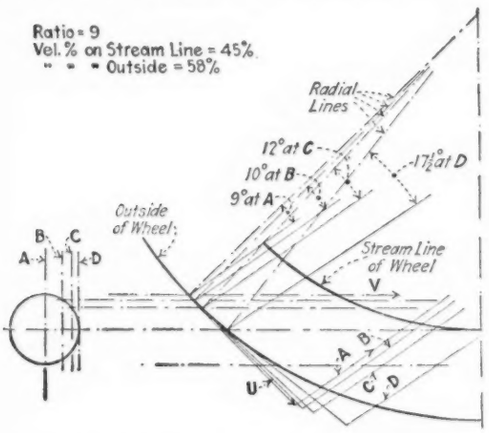


FIG. 1. ENTRANCE ANGLE AT ENTERING LIP OF BUCKET

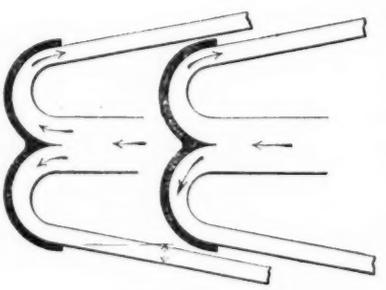


FIG. 2. DISCHARGE ANGLE OF THE WHEEL BUCKET

"In the good old days long ago they didn't attempt to make diagrams to find the correct angles for the buckets and you often saw buckets that had been runnin' only a short time with the backs all eroded and eaten out. It was a case of shock on the stream so that the water entered the bucket with a good deal of splash. I don't have to tell you this condition causes loss of efficiency."

"Pop," inquired Jimmy, "supposing that the back of the bucket where the stream strikes was cut back sharp enough so that the jet cleared it at all points, would you still have loss?"

"Yep. Theoretically, the water must flow parryllel to the relative velocity or they is shock. The jet is turned too sharp inside the bucket if the back is cut back to clear like you said, an' the water is slapped outa the path of the jet by havin' the back too blunt. In the first case you're liable to git wearin' away of the bucket on the inside and erosion on the back side, 'cause on the inside the water comes into violent collision with the bucket an' outside air gits between the jet an' the bucket back an' chemical action goes on."

"You're getting to be great on elucidating these mysteries," flashed Jimmy in admiration.

"Now, as for the discharge angles, they isn't any hard an' fast rules. Like the guy which invented the proverb, 'Whaddle you have?' an' got famous on that one line, they was once a designer which come near gittin' famous for dopin' out a way to git the discharge angles. Only, when he come to think it over he sees thet he had to make so dern many assumptions that all his beefin' about accuracy was drowned out."

"Well, how do they do it, then? Why can't it be done accurately?"

"First, it's a hard matter to tell jes' how the water discharges out of the bucket. You has to guess at it, an' it's tall guessin' at that. Second, you don't know how thick the sheet of water is that comes outa the bucket, an' it varies in different positions of the bucket with respect to the stream. Take a squint at Fig. 2. The designer I was referrin' to is a purty decent feller, outsida that he figgered the sheet of water to be of the same thickness along the discharge edge, which ain't so, it bein' more or less like a triangle with the high point in the middle. So by the time you makes all them there assumptions you might jes' as well shoot craps to get the angle, the best three outa five winnin'."

"Now then, tell us how a regular guy does the trick!"

"I said in one of our precedin' talks that they made

a few thousand tests on a lotta different styles of Pelton wheels in Europe and they went into the subject of discharge angles purty deep. From this dope we is told that they uses about 10 deg. on wheels which has a low ratio, or a big jet in proportion to the wheel, taperin' gradual-like down to about 5 deg. for large-ratio wheels.

"One or two degrees or so different one way or another on a given size wheel didn't noticeably affect the efficiency, even when it was purty clear that the water was strikin' agin the back of the followin' bucket. The fellers that run them tests, however, says that in case very small angles is used it is better to machine the edges of the backs of the buckets so the water doesn't strike on a rough surface, which would cause extry friction."

Jimmy nodded as if something was worrying him. "Say, Pop, if there was a case where a Pelton wheel

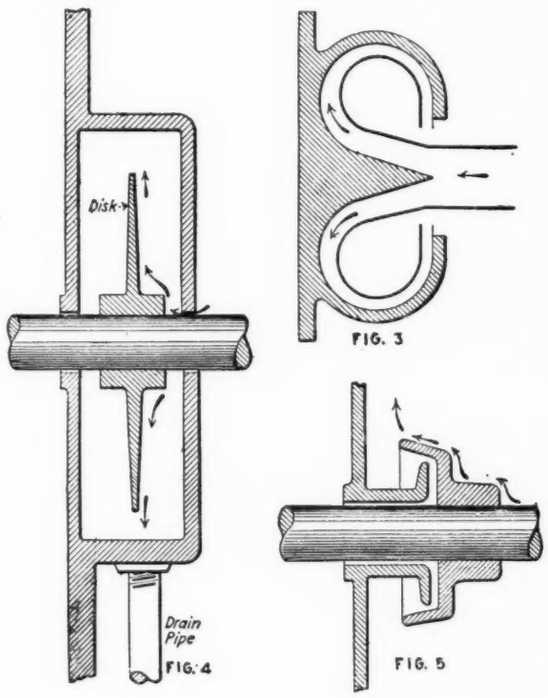


FIG. 3. ENSIGN BAFFLE PLATE. FIG. 4. CENTRIFUGAL DISK. FIG. 5. DOBLE WATER GUARD

was carrying a very irregular load, like, for instance, a sawmill or something, and the wheel was under pretty high head, whenever the load went off the wheel would speed up considerably in spite of any governor and parts of the jet slip through the wheel. Those jets would tear the daylights out of any setting you could build, wouldn't they?"

"Yep, they would." Pop thought for a minute. Then he started to draw Fig. 3. "This is the thing the lecturer told us they used on high-head plants out West. It was invented by a man named Ensign, and the patents is owned by the Pelton Waterwheel Company, I understands. The idee is that the jet splits itself on that sharp splitter and then it goes around so dern fast thet it gits dizzy and finally falls out at the bottom into the tailrace water. The splitter is always set vertical and they gen'ly is a top to it so the water don't go upwards when it splashes onto the critter. Bein' as how the thing is patented, the other firms is outa luck in usin' it on their plants, so they uses somethin' like a baffle plate so placed that it catches the water on an angle an' then guidin' it down into the tailwater."

"That's quite clear to me. Now tell us how they proportion the size of the tailrace."

"That's simple," Pop commented. "A tailrace, to be any good, must be large enough to carry off the water without lettin' it back up and flood the wheel. Then it should be wide enough so a man that has et three square meals a day can git inside of it an' work around the buckets, inspect them and see how the nozzle is. Don't git the idee you can do it through a 11 by 16 manhole, either. You might jes' as well try absent treatment."

"That's fine, but how about velocities?" insisted Jimmy.

"The velocity shouldn't be more than about 2 ft. per sec. and the bottom of the tailrace should have a slope of about 1 ft. in twenty. That'll keep the water movin' purty good."

"Now tell me something about the housings for Pelton wheels."

"I can tell you jes' as well what Paris is gonna give us next year in styles for the dear girls. They's all kinds of arrangements and styles. Some is all cast iron, some is half masonry and half cast iron, some has the part above the shaft made of flanged steel plate, others has the whole dern thing made of steel plate an' so on. I thinks I guesses purty close when I says it depends on what the purchaser looks like he can pay."

"Plenty of variety then, I see. I suppose they have stuffing boxes on the shaft to keep the water from leaking out, don't they?"

"No. They don't use stuffing boxes. They is too many cases where the water carries sand an' grit an' which gits into the packin' an' scores the shaft. The only trouble with water leakin' out is when the wheel starts and water may be driven out if they is no guard there. Now see Fig. 4. This is a disk fastened to the shaft and rotatin' in a pocket. Whatever water may git into that space is caught on the disk and shot off by centrifugal force into the pocket below, an' the drain pipe takes it to the tailrace. This critter is the centrifugal disk, patented by the Peltron Waterwheel Company.

"They is another thing which works about as good as the Pelton disk. I shows it in Fig. 5. This works on about the same principle as the other. The water is caught on the disk and thrown radially out of the way. This device is called the Doble water guard, an' when the waterwheel business and patents of the Abner Doble Co., of San Francisco, was absorbed by the Pelton Waterwheel Company, this riggin' was used on some of the Pelton plants.

"An' now, son, with this part we closes the matter of Pelton wheels, after which we'll take up speed regulation, a mighty deep subject."

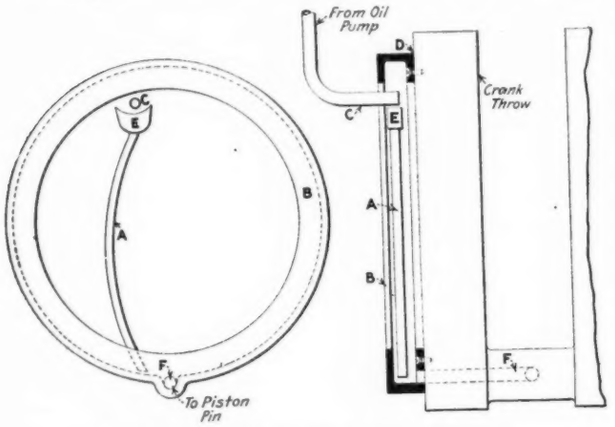
Where breaking of a piston ring caused a piece thereof to become lodged under a valve, resulting in the piston making a violent movement and causing injury to an employee, the employer is liable if it can be shown that the piston ring was badly worn before the accident and that the foreman in charge knew of that fact long enough to have permitted repair of the defect before the accident occurred. (Springfield, Mo., Court of Appeals, Yarborough vs. Wisconsin Lumber Co., 211 Southwestern Reporter, 713.)

Lubricating Oil Not To Blame

By L. H. Morrison

Frequently, after using any given lubricating oil on an oil engine, difficulty is experienced if a change is made to another oil. Many times the second oil gets an undeserved bad reputation in a plant. Recently, I went through such an experience that for a time was quite a puzzle. The unit was a Bohinder vertical hot-ball engine which was in poor condition. It was necessary to keep it in operation, and the crankpin bearings were burning out about every third night.

Investigation revealed that for some time a heavy



SHOWING THE OILING CONNECTIONS

valve oil had been used as a cylinder and bearing lubricant. This oil, while unsuited for use in an oil engine, apparently had been serviceable in this particular engine. This was due no doubt to the large clearances which the heavy valve oil served to reduce. Being in the Tropics, remote from oil stock, the supply of valve oil had become exhausted, and a few barrels of a fairly well-known Diesel lubricating oil had been purchased at a local station.

The writer found that this oil had not given service, causing, as already stated, ruined bearings about every third night. Feeling that the oil, while suitable for a Diesel, might possibly be at fault, a barrel of oil especially adapted for use in this particular make of engine was secured. The bearing trouble was not reduced, and it appeared for a while that the oil had received a setback in that plant.

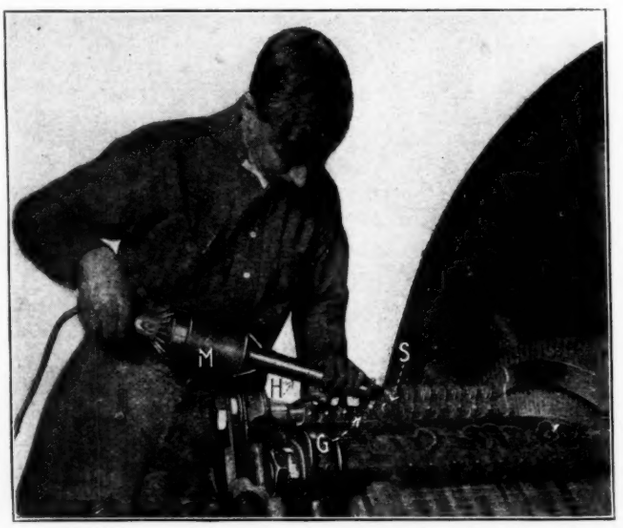
Upon thoroughly overhauling the engine, it was discovered that the oil was blameless. The crankpin was lubricated through a centrifugal ring, as appears in the sketch. The oil pump delivered the lubricant through the pipe *C*, which discharged it into the cup *E*, whence it flowed through the pipe *A* into the ring *B*. This ring allowed it to flow through the passage *F* to the crankpin. The cup *E* had become slightly misplaced, having shifted to the left. The valve oil was heavy and, as it left the end of the pipe *C*, dripped down into the cup and to the crankpin. The lighter Diesel and semi-Diesel oils, since they flow more freely, issued from *C* with enough velocity to completely miss the cup *E* and ran down between the oil ring and the crank-throw at *D*. Little oil reached the pin, and of course the babbitt overheated.

By shifting *E* to its proper position and bending the end of the pipe *C*, the oil was forced to enter *E*. Having done this, no more bearing trouble was encountered. Frequently, lubricating oil is condemned when actually the fault lies in some misadjustment of oiling devices.

Portable Tool for Undercutting Commutator Mica

Three features in the modern direct-current machine stand out as the most important for sparkless commutation and therefore satisfactory operation, namely, commutating poles, brushes of proper characteristics and undercutting the commutator mica. High mica in commutators has probably caused more operating troubles with direct-current machines than any others that commutators are subjected to. So well recognized has this fact become that many electrical manufacturers are undercutting the commutator mica before putting their machines on the market.

Undercutting mica must be done with some kind of a tool, of which many have been developed, ranging from a piece of hacksaw blade fastened in a wooden handle to power-driven machines used in large repair shops and armature departments of large electrical manufacturing companies. The illustration shows a portable tool for undercutting mica, known as the Aurand commutator slotter, and has been placed on the market by J. H. Green & Co., Chicago, Ill. This tool is a hand-operated power-driven machine, the essential part of which consists of a 1½-in. circular saw *S* keyed to a hollow mandrel, on which is mounted a worm gear. The hollow handle *H* contains the steel driving shaft with a worm and a small universal motor *M*. Immediately behind the saw travels a thin metal guide shoe *G*, which slides in the slot, thus insuring a straight cut. Adjustments are provided so that the machine is serviceable for any size of commutator and will cut to the prescribed depth. The saws are of different thicknesses to take care of all commutators. Mica in different commutators varies approximately from 0.018 in. to 0.035



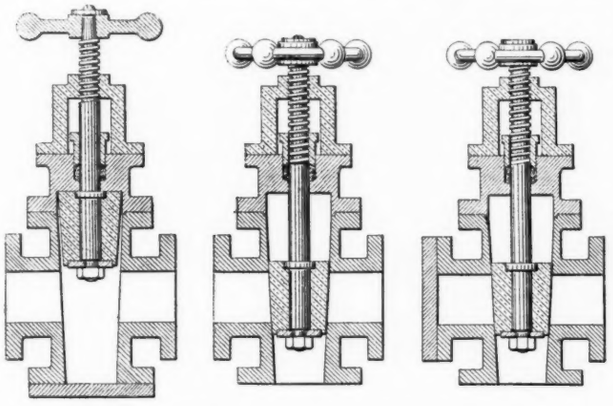
MICA UNDERCUTTING TOOL IN OPERATION

in. The rate of speed at which mica can be cut with this slotter depends upon the length of the commutator and the grade of mica, and upon the operator himself. On large machines from 20 to 30 in. per min. can easily be cut.

From the figure it is evident that the tool can be used without removing the brush rigging; therefore, the work can be done at a time when it is convenient to shut the machine down. The driving motor is of the definite-pole type, series wound, and is furnished for either 110- or 220-volt service, either of which will operate at 25 to 60 cycles.

Universal All-Service Valve

The chief characteristics of the Universal All-Service valve are that it can be used as a straightway, angle or three-way valve by simply changing a flange. The valve has a full opening as large as the pipe area, and a pocket is provided underneath the disk to catch any sediment or foreign matter that may enter the valve when it is in the open position. The flange under the



SHOWING STRAIGHT-WAY, THREE-WAY AND ANGLE VALVES RESPECTIVELY

seat can be safely removed while the valve is under pressure, but in the closed position, so that the foreign matter that has accumulated in the chamber under the seat can be removed. The disk is made round and tapered, and it never seats twice in the same place in succession. The illustrations show the design of this valve, which is perfected by the Universal All-Service Valve Co., Cleveland, Ohio.

In large sizes, where a bypass is necessary, connection is made with the valve body to the bottom flange, and when pressure is equalized, opening this valve exerts the pressure on the bottom of the disk, which acts as a piston and assists in opening the valve. It should make an excellent blowoff valve, and when using two, as is the general practice, the danger of leakage should be practically eliminated as the seats are out of the flow and impinging of scale and other impurities does not harm them.

In case the valve stem breaks, it can be safely changed while the valve is under pressure by first shutting the valve, disconnecting the bottom flange and the top bonnet flange, when the new stem can be fitted in the valve body through the cone disk and after tightening the stem nut and replacing the flanges, the valve can be put back into operation.

Danny Hogan On Length Of Course Sheets

"I see be the *Power* paaper the editor do be inquiring why thim beaneaters in Mass. an' the highbrows on the biler-code comitty are limiting the length of a course sheet for horizontal return-tubular, vertical an' locomotive bilers," says Duffy, as he plied his dudeen at the Dutchman's.

"True for ye," said Doolin, "an' I'm glad ye read *Power* that close."

"Why," says Duffy, "do it be as it is?"

"Well," says Doolin, "after I get meself outside another scuttle of this 2.75 suds, I'll be telling ye the answer." The ceremony duly executed, Mr. Doolin relighted his ancient but mighty pipe and then resumed: "Ye should know, Duffy, of all biler explosions on record about the worst was those horizontal return-tubulars made wid one sheet on the bottom an' running from head to head wid two continuos seams lap-joint double-riveted from ind to ind, the seams bein' buried in the brickwork on the outside an' below the tubes on the inside. Bad enough to have lap seams, Duffy, but in these, wan had twice as much of thim and never could they be seen in practice.

"An', Duffy, I would again for the nth time, as the highbrows term it, remind ye that in them old happy days no one could make a sheet cylindrical at the ends when it was cold-rolled. So there was the flat place at each ind where the long seam would be, an' this was true of the early commercial butt-strapped bilers."

"What's a commercial biler?" asked Duffy.

"Well," said Doolin, "I hate to tell ye, but it was made to sell, wid rivet holes punched full size and costs rejuced as far as could be widout a strike. Be that as it may, the bald fact is the one-sheet-on-the-bottom H.R.T. beat the record in explosions. I have only a few in mind, such as the Detroit Journal wid 36 lives lost, the Penberthy Injector wid 29 lives, Swifts at Chicago, 13 gone, and many wid lesser cost of lives.

"Th' arguement advanced in making thim bilers was that the bottom was considered as a beam which would be weakened by cutting it in halves and riveting it together, making, say, a 52 per cent. joint. Also, it was thought good to avoid a girth seam in the fire. So the best of the shops fell for it utterly, neglecting the flat spot at the seams an' the springing of the rolls on long plates, the punching rivet holes full size, and the malicious drift pin and sledge of the lads doin' the riveting.

"An' ye want to know, Duffy, it's some job to take two troughs like the two halves of a 72-in. x 18-ft. biler and put them together to make a true cylinder, considerin' the 5-in. flat places at the edges. So 'tis no wonder they blew up since not bein' cylindrical, there was a constant bendin' action in an out at the long seams."

"So," says Duffy, "that's why they limit the length to 12 in., is it?" nodding to the waiter as he spoke.

"Well," says Mr. Doolin, "ain't that reason enough for what we made in the old days? But I'll tell ye if shops can make a biler widout the flat plate at the long seam, and I refer now to butt-strapped jints since the laps are out of style, there be no reason at tall why we can't make the plate 18 ft. or 24 ft. long. It depinds on special tools to work widout hurting the plate and to have no flat spot at the edges where the long seam do be.

"For meself I believe the plate mill should cold-roll the plates and have a big special ball roller to travel from end to end of the rolled sheet, that the flat section at the edge would be trooly cylindrical, and beyant that, the straps should be made at the plate mill and curved to the required radius, which be more and less than the biler shell. The thing of sledging straps in shape or trying to bring them about in shape by using a narrow, heavy piece of plate in the old rolls, belongs to the Jawn L. period, Duffy, an' is a rayson why the rules lay down on sheets over 12 ft. long for fire-tube bilers, tho' why they don't include water-tube bilers is no logic at all.

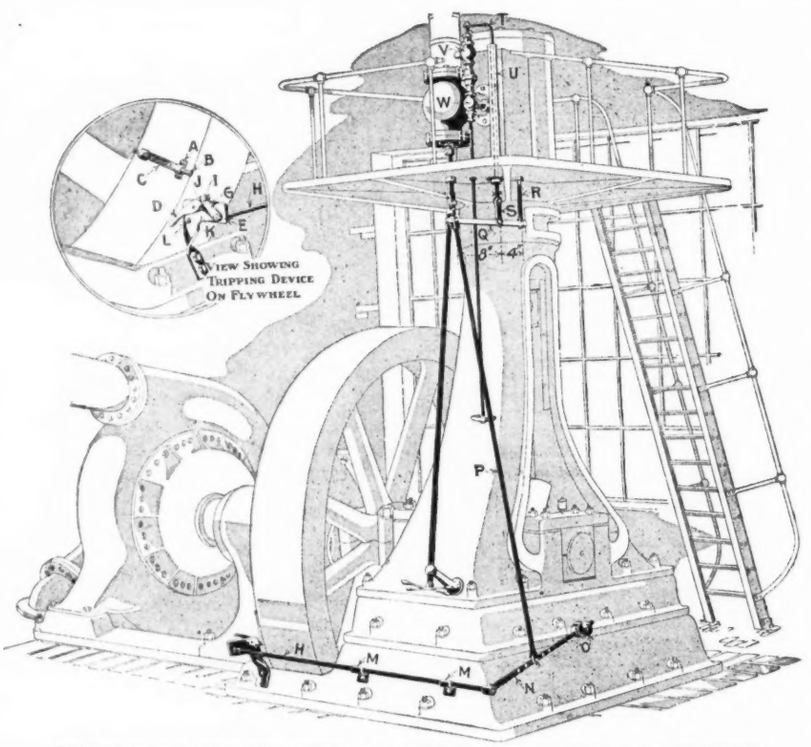
"I've seen as many bum jints on water-tube drums as on fire tubes when it comes down to brass tacks, an' eliminating the Bull of trade, the fire-tube biler can hold its own wid the best of thim. An' by the way, Duffy, why do so many of thim water-tube bilers explode by failure of the drum heads, and what do they be doin' to improve on this line? I'll ask ye that," says Mr. Doolin.

"Put it up to the paaper," said Duffy.

Home-Made Engine Safety Stop

Engines driving auxiliary units in a power plant should be safeguarded by some kind of safety stop. Many of them are not so protected, but in one instance at least the engineer designed a home-made safety stop and applied it to two vertical engines directly connected to centrifugal pumps that were used for providing condenser circulating water.

Attached to the rim of the engine flywheel is a casting *A* in the body of which is a pin *B* held in place by a spring *C* under tension so that the outer end of the pin does not protrude beyond the edge of the casting when the flywheel is running at normal speed. The tension on the spring is such that should the engine speed up a certain number of revolutions above normal, the centrifugal force exerted on the pin would overcome the tension of the spring and the pin will project beyond the casting sufficiently to strike the end of the latch *D*, which is pivoted on a bolt on the angle iron *E*, that is securely bolted to the engine bed, as shown at *F*.



HOME-MADE ENGINE STOP AS APPLIED TO A VERTICAL ENGINE

A dog *G* is secured to a shaft, and the projections *I* and *J* latch when the latch *D* is against the stop-pin *K*. The stop-pin *L* is to prevent the latch *D* from moving too far when struck and tripped by the pin *B*. The latch-pin *D* is 10 in. long, ⅜ in. wide and is made with an easy curved surface on the face side. The angle iron supporting the latch *D* and dog *G* is of iron 2½ in. wide and ⅜ in. thick.

The ¾-in. shaft *H* is supported at the opposite end from the angle iron *E* by two bearings *M* and carries ¾-in. diameter weight lever *N*, on the end of which is 4-in. diameter weight *O*. This weight lever is drilled with several bolt holes, through one of which the ½-in. rod *P* is attached. This rod connects to one end of a rocker rod *U*, which is pivoted at the outer end to a ½-in. round stud *R*.

About midway of the arm *Q* a short link *S* is loosely pinned at one end and connects to a vertical rod *T*, which is supported by a hollow stand *U* that is secured to the engine grating platform.

The engine was originally piped to a 5-in. steam line with an angle valve connecting with a steam chest by a short nipple. This pipe was found to be too large for the service required, and a 1½-in. angle valve *V* was therefore connected to the steam pipe above the 5-in. valve, and a second valve *W* of the same size, to act as a throttle valve, was connected to the first by a short nipple at one connection and the other to the 5-in. nipple connecting to the steam chest. The valve *W* was fitted with an extension valve stem convenient for the engineer to manipulate from the floor. With the latch *D* and the dog *G* latched, the valve *V* will be open, and with the valve *W* open the engine speed is controlled by the governor.

In operation the device works as follows: With the engine running at normal speed, the pin *B* does not project far enough beyond its housing to strike and trip the latch *D*, which is holding the dog *G* in a locked position. In the locked position the weight *O* is in its highest plane and the valve *V* is consequently opened. Should the engine speed up beyond a predetermined number of revolutions, the pin *B* is thrown out to a position that causes it to strike the latch *D*, which trips the dog *G* and the weight *O* moves the lever in a downward direction, which motion is transmitted to the valve *V* through the rod *T*, thus shutting off the steam to the engine. The engine cannot be started again until the latch *D* and dog *G* have been engaged in the set position. Every engineer doubtless realizes the danger that is present when an engine is operated without a safety device of some kind. The foregoing illustrates how easily an engine can be protected against overspeeding by making a home-made safety stop that is within the reach of all, is inexpensive to build and one that can be made by anyone possessed of a little ingenuity.

A contract whereby a power company agreed to perpetually furnish electric current to a manufacturer, in consideration of the latter's transfer to the company of power created by a dam was not abrogated by the subsequent enactment of the Illinois Public Utilities Act. A state may regulate the charges and business of a public utility furnishing power, so as to protect the public against unreasonable charges and unjust discrimination and to promote the public welfare, but an act purporting to abrogate vested rights, such as that acquired by the aforementioned manufacturer, would be unconstitutional as a deprivation of property without due process of law. (Illinois Supreme Court, Schiller Piano Co. vs. Illinois Northern Utilities Co., 123 Northeastern Reporter, 631.)

EDITORIALS

Real Co-operation

ONE of the fine things that the strike brought out was the spirit of appreciation of our difficulties and approval of our course expressed by our patrons, subscribers and advertisers alike. We have been unable to acknowledge these kind and encouraging messages individually, but take this means of assuring their authors of the satisfaction with which they were received, and the appreciation which they evoked on the part of all who have been concerned in formulating and carrying out the policies which they commend. A few excerpts from these letters follow:

I do not know what your intentions are with regard to back numbers, but for my part I want to thank you for the way in which you have kept us in touch with what was going on in the power field.

I hope you do not think you should make up back numbers or extend subscriptions. We all appreciate what you have been up against and the way you have handled it.

Received my Oct. 7 issue today and have been giving it the once over. It is like getting home after a long absence—mighty good to be *back*.

I will just write a few lines to let you know that I am well pleased with the stand you are taking during the strike in not attempting to publish *Power*. I am afraid that I would have to discontinue my subscription if you should try to publish *Power* with strike breakers.

As a subscriber to *Power* I wish to thank you for the trouble you have been to, to keep us posted on things in the engineering world.

I sincerely hope that the time is close at hand when your troubles will be adjusted and conditions will be normal, for your benefit as well as my own.

While I am a firm believer in organized labor, it seems to me, to use an expression common among the natives here, that labor has "gone hog wild."

But I hope the pendulum has about reached the end of its stroke and will soon start on its return.

In the meantime we will mark time and wait for the return of *Power*.

I have been a subscriber to *Power* for over fourteen years and have never missed a copy until the strike and it is like losing an old friend to be without it. I intend to remain a subscriber to *Power*, strike or no strike, for to again quote the natives, "I am with you from hell to breakfast."

I wish to express myself in some manner which will give you assurance that myself as well as many others who are subscribers to *Power* are perfectly willing to sit tight in the boat and wait until conditions readjust themselves. In other words, we are with you and will continue to take *Power* whenever you can issue copies of the same.

These are representative of a large number, a convincing and grateful demonstration of the cordial and sympathetic relations that exist between *Power* and its readers.

Fill Up the Coal Hod

THE industries of the country, the transportation of the nation, the domestic life of the community are threatened by the shortage of coal.

The miners claim that they cannot live on the pay that they are getting and called a strike. The rate per ton or per day is not so bad if the employment were steady, but the miners must stay around and report for duty all the time for the sake of a chance to work part of the time. They therefore demand a sixty per cent. increase in wages and a six-hour day, claiming they can mine in that time all the coal they are mining now and that the increased wage rate is needed to meet the increased cost of living.

Secretary of Labor Wilson says they ought to have an increase in wages of thirty-one per cent. Fuel Administrator Garfield says an increase of fourteen per cent. will put them on a parity with other trades.

Ex-Secretary of the Treasury McAdoo says that according to their income tax and excess-profit returns the operators have been making from one hundred to a thousand per cent. of their capital stock, and that they can afford to meet a considerable increase in wages without raising the price of coal to the consumer.

The President declared it unlawful for a body of men to conspire to restrict the production or distribution of so vital a necessity as coal, and the Government enjoined the strike, which was called off by the leaders. Whereupon there was a great outcry about "involuntary servitude" and the inviolability of Labor's right to strike. Ex-President Taft points out that if the purpose is lawful and the method is lawful, the right to strike must and will be preserved and respected by the courts, but if the strike is for an unlawful purpose, it is no more under the protection of the Constitution than any other unlawful injury or crime.

Nothing but unsupportable conditions, to relief from which all other avenues were closed, would justify a body of men in holding up the fuel supply of the nation on the verge of winter. If there was ever such justification for the strike of the miners, it is over now. Their case is before the representatives of the people if not before the people themselves. They can secure no more thorough or favorable consideration of it by impeding the railroads, stifling industry and causing no end of discomfort and expense in public institutions and private homes. To continue to do so will be the best possible way of alienating that public sympathy which they need if their case is to be won.

Let them get busy and fill up the coal hod while the discussion goes on.

Let the public into the discussion and give it the benefit of the facts.

The people are the ones who pay the wages of the miner and the profits of the operator and middleman. They have a right to know what they are paying for.

They want the miner to have money enough to live and bring up his family in accordance with the American standard, and save enough to support himself when his productive period is over. But they don't want to be held up for an extravagant raise by a threat of having their fuel supply cut off in the dead of winter; and in the absence of any explanation, sixty per cent and a six-hour day looks like a hold-up.

They want the operator to get a fair profit, not on a paper valuation, but upon the cost of operation, including a fair interest on the capital actually invested.

The situation has all the possibilities of serious

trouble. We hope it will be settled before this issues from the press. But whether it is or not, let us have the facts. Put the cards on the table, face up. How much did the average miner make year in and year out at the prices prevailing before the strike? How many hours a year did he work and how many hours did he have to stand around ready to work? How much have the operators been making? How much of the proposed increase in wages do they purpose taking back from the miners by increasing the cost of his necessary supplies?

Information of this sort rather than execrations of the capital and wage system or florid denunciation of radicalism is what the public needs in order to make up its mind as to the merits of the case, and as the public makes up its mind so is the thing likely to be settled in the long run.

And there is one thing that the public has already made up its mind to, and that is that it wants its coal; and any act of operator or miner which interferes with the prompt resumption of its mining and distribution at a normal price will prejudice his case in the eyes of this court of final appeal.

Measurement Of Maximun Demand

WHEN an industrial concern contracts for electric power or when the user of electricity receives the monthly bill, it will often be found that the charge is based on two rates—the total number of kilowatt-hours used and the "maximum demand." This additional charge is often mystifying and hard to justify without knowing the reason for its existence. Electricity is not like water or gas, which may be pumped or generated at a uniform rate over a period of twenty-four hours and conveniently stored until the customer wishes to use it, when he may use a large quantity in a short period without making it necessary to increase the size of the twenty-four hour pump or gas generator. In such a case there is no reason why a customer should pay more because he uses a larger quantity in a short time, as the equipment need not be any larger.

But electricity cannot be stored commercially; it must be generated only as used. Consequently, the size of the generators and other equipment must be large enough to supply a twenty-four hour load equal to the customer's greatest power demand, even though he uses the power only for a short period per day. This is why a large power bill is seldom charged according to the kilowatt-hours only. The cost of equipment depends also on the rate of consumption; consequently, the additional charge of so much per kilowatt of maximum demand.

On another page of this issue is an article "Measurement of Maximum Demand," giving an example of how the maximum-demand charge affects the monthly bill. This is followed by simple directions for determining the maximum demand with the ordinary watt-hour meter and a list of the various principles of operation employed in maximum-demand meters, which should assist in clearing up this feature for those not familiar with a maximum-demand charge.

Industrial concerns with a maximum-demand clause in their power contracts may find that by a proper division and supervision of their loads it is possible to effect a large saving in the electric bill, simply by extending the load over as long a period as possible and avoiding the use of an excessive maximum demand. For instance, if the motors driving the plant machinery are shut down at the noon hour, this period may be used to pump a tank of water in preference to pumping when the other motors are running. Or if several large grinders are used, the work can be arranged so that one is being refilled while the other is in operation. Or if the plant must be operated evenings with all the lights burning from the power circuit, some unimportant machine can be shut down. Numerous cases will present themselves to the alert engineer which may result in a considerable reduction in the power bill when using the same amount of power, but simply keeping the maximum demand as low as possible consistent with the total power consumed.

Is the Owner About to Understand His Engineer's Problems?

"Why didn't you say that in the first place?" How often one hears that question exclaimed. There cannot be appreciation of another's point of view when there is lack of understanding or when there is misunderstanding about them and their related circumstances. This is the chief reason that power plant owners and industrial plant managers so little appreciate the problems of their power plant engineers, and, therefore, co-operate not at all or inadequately.

Several attempts have been made to bring engineers and managers together to the end that each might better know the other, not in a fraternal way but in a business sense. No attempt seems so capable of bringing real, lasting results as that made by the Educational Committee of the Manufacturers' Association of Knoxville, Tenn. Through the association's efforts the University of Tennessee is now conducting power plant courses financed by the engineers. The courses extend over twelve weeks and there will be two terms. The complete course with books costs each student ten dollars.

The plan differs from that of the University of Wisconsin, but both are alike in purpose. It is too soon to tell what those in Tennessee will accomplish, but the greatest obstacle was overcome when the owners and managers agreed to meet with the engineers. They will have a banquet this winter conducted by the engineers.

The Phillipsburg, N. J., Association of the National Association of Stationary Engineers is another body which has accomplished things worth while in this direction. The manufacturers are with them to such extent that they attend association meetings and see to it that every assistance and opportunity is given the engineers to promote their work. The manufacturers of Elizabeth, N. J., are now interested and the coming season likely will see closer co-operation between them and their engineers.

Salaries play no rôle in these get-together meetings; it is the betterment of power plant efficiency that is sought.

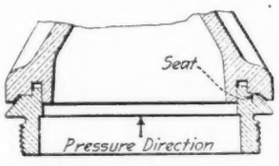
These manufacturers are wise indeed. The engineers are anti-radicals by tradition. They are too keenly aware of their vital importance to public welfare, too appreciative of their far-reaching responsibilities to betray their trust and themselves. They are too American to think that they must cripple all industry to get a hearing, not about wages, but about bettering the efficiency of that basic thing upon which all modern industry depends—power generation.

It is truly up to the plant owners and managers to take advantage of such excellent esprit de corps.

CORRESPONDENCE

Water-Column Blowoff Valve

I have read various communications printed in your magazine concerning valves for water-column blowoff service, one being in the issue of July 1, page 27, and another in the issue of Sept. 23, page 518. We believe that there is something in all these arguments, but it seems that none of the writers has yet given a solution of the difficulty.



DESIGN OF DISK AND SEAT

Water-column blowoff service is similar to boiler blowoff service in that it is a valve that is subject to extreme temperature changes and the passage of a certain amount of grit and dirt over the holding faces. There have been all kinds of development of a suitable valve for boiler blowoff service, and I believe that the only reason there has not been the same development for water-column blowoff service is because of the ease with which these small valves may be taken out and replaced; nevertheless, this replacement is a continual nuisance and in proportion as much an expense as the upkeep of blowoff valves.

A blowoff valve with a protected seat and disk, as illustrated, would solve the problem and, if used, water-column blowoff difficulties will be vastly decreased.

It is particularly suited to take care of the differential expansion between the internal and external parts of the valve. The body has a coefficient of expansion of 0.0000154, while the internal monel parts have a coefficient of 0.0000076. Therefore, when this valve cools, the disk is really pressed tighter to the seat than when closed off while hot, thus insuring against this seat lifting when cooling down.

Pittsburgh, Penn. B. M. HERR.

The Education Of An Engineer

In the course of my experience as an engineer I have worked side by side with, and have been in a position to become intimately acquainted with, a great many engineers of different types and various degrees of ability. When you work side by side with another man, or in the same plant, you have an excellent opportunity to discover just about how much he knows. If you are a keen observer, you will soon be able to ascertain whether the other man is good, fair or poor in his ability as an engineer.

It is interesting to observe that the average engineer will cram his brain full of technicalities in preparation for his engineer's examination, because he could hardly get a license without it. After he has secured his license he is done with the dry, uninteresting textbook. He has had enough of that. This is just where he makes a mistake. A good textbook is an invaluable thing. An engineer should freshen his memory continually, strive not to forget the things that he has learned and endeavor to keep up with the advancement of the engineering art, as there are new ideas being developed every day.

In the columns of the trade journals he can read of the experiences and problems that were confronted by his fellow-craftsman, and he will find the solution to many a kinky problem and a great deal of the technical knowledge that the average engineer requires there, and I have noticed that the engineers who fail to read the popular journals are few and far between.

Los Angeles, Calif. ROLAND L. TULLIS.

Different Water Levels In Heating Boilers

On page 519 of the Sept. 23 issue of *Power*, in response to an inquiry as to the cause of the variation in water level in two cast-iron sectional heating boilers connected together, you state that the trouble undoubtedly arises from the difference in the loss of pressure in the return water. You further state that with the ordinary sizes of steam connections the steam pressure in the boilers would be substantially the same even for considerable difference in rates of evaporation, and although this trouble is commonly attributed to the difference in steam pressure, trouble from that cause is rare.

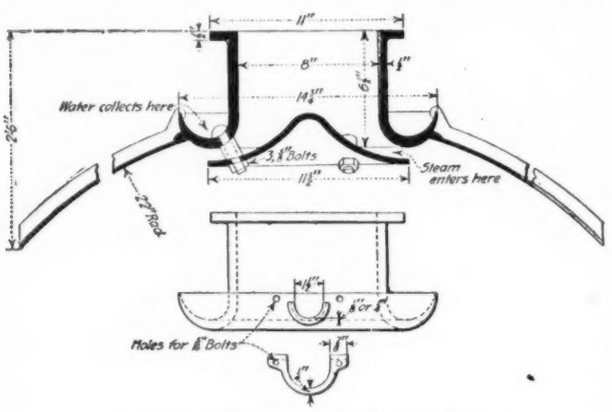
My experience leads me to believe that the trouble is usually due to steam connections that are too small and that if connections of the size generally used are installed there is likely to be trouble from this cause. On the other hand, with returns of the sizes that are customary in steam-heating practice, the friction of water flowing through a wet return is almost negligible. When two boilers are connected to one set of mains and are fired alternately, one boiler will at times be worked at a much higher rate of evaporation than the other and, in fact, under an active fire do much more work than it was designed to do. Under this condition there will be an extensive drop in pressure between the steam space in the boiler and the main; so extensive, in fact, if the steam connections are not unusually large, as to cause the water to disappear from the glass. This can be corrected either by making the branch steam pipes and the main larger or by adding an equalizing pipe of proper size between the two boilers. It is a practice of the office with which I am connected to be very liberal in the matter of steam connections when two or more boilers are to be connected to one main and to make no difference in the size of the return connections.

New York City. HENRY C. MEYER, JR.

Why Does the Water in a Boiler Lift When the Safety-Valve Blows?

The editorial in *Power* of the June 24 issue, "Why Does the Water in a Boiler Lift When the Safety Valve Blows?" interested me considerably. I was not aware that there was any great amount of trouble from water being lifted when the safety valve opened, but even if the valve does lift quickly and high, I have never had any trouble from this cause. I have, however, had experience with water being carried over in the main steam pipe, both as wet steam and as entrained water.

Having been a boiler inspector for twenty years, I have paid considerable attention to the quality of steam delivered. In inspecting boilers I have paid particular attention to the kind of dry pipe or separator used and the height of the water line near the steam outlet. I have always found the water line higher on the shell (either in horizontal-tubular or water-tube boilers), right opposite the steam outlet on both sides and streaks on the shell, indicating that the water crept up the shell to the steam outlet, and that the longer the dry pipe the wetter the steam, caused by the extra length of pipe acting as a collector of water instead of as an



SEPARATOR FOR STEAM BOILERS

eliminator. As the round separator is fastened to the steam pipe inside of the boiler and taking the steam from the top near the shell, it, at times, furnished very wet steam. Boilers with such devices cannot be driven very hard without sending over considerable water and there is almost always considerable mud in the opening of such separators. This all indicates that it was carried there by the water.

If there is trouble from water lifting when the safety valve blows, I am sure the most of the water comes up around the shell to the safety valve, if the water is 18 in. or more away from the opening. Even an angle fastened to the shell, two or three feet long on each side above the water line, has been known to help considerably in keeping the water from being carried over to the engine.

Acting on this information I patented an inside separator that collected any water that may be carried up on the shell, and that which is constantly dripping down from the shell, and conducted the water back to the water line in the boiler in such a way that it cannot be swept up by the outgoing steam. The device was so shaped as to get the largest quantity of steam out through a given opening and causes the least disturbance of the water, by shaping it so as to prevent, as far as possible, any whirling motion to the steam which would cause it to act on the water in the boiler and cause a water spout. This might be what happens when the safety valve rises quickly and high as mentioned in the editorial. This separator, see illustration, has been very successful and by making the opening the proper size I can deliver steam with less than one-half of one per cent. of moisture.

A conical baffle plate on the bottom of the separator prevents the water from rising from the surface and regulates the size of the outlet. In providing a device to keep the water from being lifted by the safety valves it would be better to leave the baffle plate off, if possible, as then there would be no restriction to the outgoing steam. It appears to me that if the water which creeps up the side of the boiler is prevented from going out the steam would not be wet enough to cause trouble. I am sure that I can make the device so that the safety valve will not draw up the water, and at the same time be reliable and allow the safety valves to take the required amount of steam.

In a certain office building there are three water-tube boilers. The engineer and the superintendent of the building complained to the maker of the boilers that they were furnishing wet steam. The boilers' maker, knowing of my separator, asked me to see what I could do. I put a separator on each boiler, first trying out one boiler and then running this one boiler with forced draft with the water almost up to the top of the water glass, the moisture in the steam was less than one-half of one per cent. In making the calorimeter tests I found that the steam was drier when the water was high in the water glass than when it was low, and that when it was real low it had a tendency to get wet, just the opposite to the general belief.

After a little consideration I discovered the cause of this. The steam outlet on these boilers is on the front of the drum, directly over the front header where the water circulates up into the drum. When the water was high this rapid circulation, with the force of the draft on, could not spout up through the water and mix with the outgoing steam; but when the water was low the water shot out of the header in geyser-like action and mixed with the steam. There was no trouble to get dry steam with two or three inches of water in the water glass. Such might have been the case with the safety valves in question.

J. F. FENNELL.

Philadelphia, Penn.

Nearly all engineers think that a high velocity tends to lift the water in a boiler. If this is so, then the smaller the valve handling a given amount of steam the greater will be the velocity and more water will be carried over. For instance, a 3-in. valve, having a capacity of 8650 lb. of steam per hour at 125 lb. pressure, would have a tendency to lift more water than would a 4-in. valve under the same conditions. I think that the subject is a very important one and should be given all the attention possible.

I was recently called on to design the piping in a large power plant, and the question of pipe size from the boiler to the header was important. The boiler was supposed to have a generating capacity of 6000 lb. steam per hour, at 150 lb. pressure. The boiler nozzle was 9 in. and the engineer in charge insisted that I make the pipe 9 in. from the boiler to the header. This would have pro-

duced a velocity of approximately 600 ft. per min. and a drop of only 0.015 lb. per hundred feet. This low velocity would cause considerable condensation and would be too low to properly operate the nonreturn valve. I insisted that the pipe should be reduced to 5 in. which would create a velocity of 1980 per min. and a corresponding drop of 0.275 lb. per hundred feet. This velocity and drop I believe are considered very low and should be at least 4000 ft. per min. and approximately 1 lb. per 100 ft. respectively. This would require a 3-in. pipe.

This engineer is now complaining that owing to the pipe being reduced to 5 in., the boilers are priming, and he has requested that we make the pipe 9 in. I contend that these boilers are priming because they are very much overloaded and that a 9-in. pipe will only make it worse. I would like to have some expert opinions on the subject. Does high velocity through pipe or valve on boilers tend to lift the water? There is a statement made by one of our best writers that the "drop of pressure of steam does not cause a loss of energy." If this is so, and a high velocity does not tend to lift water, then why not increase the velocity and use smaller pipes?

Memphis, Tenn. H. T. FRYANT.

What lifts the water from the level of the water line and throws it out of the safety valve? This action of the water is inevitable in all safety valves and the same action is implied in the steam leaving the boiler through the steam pipe leading to the engine, with the added damage resulting therefrom.

I have found that the wreckage of hoisting engines is caused almost exclusively by the water being drawn in slugs into the steam pipe and then into the engine, where according to natural law no two bodies can occupy the same space at the same time, it compels such quick action that something must give way.

The wreckage occurs by the piston striking the water in the cylinders so suddenly as to tend to stop it, and the momentum of the heavy winding drum does the rest. Any one of a dozen parts may break; the crank, the crosshead or the piston itself. The crankpin may be loosened, or the strap bolts of the connecting-rod may be sheared, the cylinder head smashed, or as an alternative the water may escape by lifting the valve and passing into the exhaust. But water is solid and would have to back up the side pipe instantaneously or a little quicker, to relieve the pressure. Pillow block caps and bolts are broken by the shaft, including perhaps a 15-ton drum being jumped up to let the crank pass over, or the bedplate may be broken.

Away back in steamboat times this experience was thrashed out and decent results obtained, after innumerable smash-ups, by using large steam drums, and large outlet pipes or legs connecting the boiler and the drum and by making the end of the steam pipe project into the drum near the center to avoid the slugs of the water from the boiler. All of this experience is now ignored or forgotten. C. W. CRAWFORD.

Brazil, Ind.

I am much interested in the subject of safety valves, their size, lift, sudden release, etc., which was brought up in a recent editorial in *Power*. It seems to me that A. S. M. E. acted wisely in removing the limit on the amount of lift of safety valves, but I cannot say the same in regard to the removal of the limit on the size.

In my opinion the gradual opening of the valve has no bearing upon the amount of priming caused by the blowing of the valve, provided, however, that the water level is not so extremely high at the time that any sudden release of pressure may cause a rupture to occur.

Getting back to the question of size, it is my belief that the removal of the limit on the size is a step backward and that instead of taking this step we ought to go in the opposite direction and make safety valves smaller. Take, for instance, a boiler running, say, at 200 per cent. of rating; the allowable pressure is exceeded and a safety valve large enough to discharge all the steam the boiler is capable of generating "pops," adding another 250 per cent. or more of rating to the load on the boiler. Under these conditions what else can the boiler do but prime? And it does prime, not only through the safety valve, but also into the steam main.

If, however, this same boiler had been provided with several smaller valves set to blow a few pounds apart, then when the pressure exceeded the limit the first of the valves would open and add, say, 40 or 50 per cent. of rating to the boiler and probably little if any priming would take place; and if for some reason the entire load was taken off the boiler while driving at a high rate, all the valves or as many as was necessary, would go into action as their respective pressures were reached.

This, I believe, is the only sensible method to secure safe and gradual release of pressure in any boiler.

East Chicago, Ill. CHARLES L. ANDERSON.

Breaking of Wedge-Bolts

I have read of several instances where the breaking of wedge-bolts has caused trouble, and it may interest engineers who have gone through this hair-raising experience on their first introduction to that gentle knock at both ends of the stroke when the throttle is almost tight.

The first time I heard this knock I did not know whether to get outside the plant or stay inside. Anyhow I stuck, and after looking things over I found that the only damage done was to the adjusting wedge-bolt on the crank, the head being broken off short. A day or two later another one broke, then another, and still another. I began to see all kinds of things happening. My imagination of what might happen ran into a nightmare. But I started in to overcome it. I shaped the heads on the bolts so as to eliminate a sharp corner, making them of tool steel and annealing them; but they broke just the same.

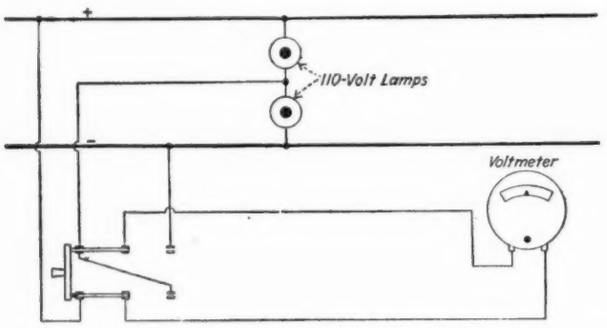
Finally, I recollected that Norway iron is about the toughest thing known in the metal line. So I got a bar of the right diameter, cut it into lengths about four inches longer than the bolts and had the blacksmith upset one end large enough to shape up a head. Then the machinist made up the bolts to fit. This ended the trouble. B. GADDIS.

New Rochelle, N. Y.

In a recent case (Norfolk & Western Co. vs. Royal Indemnity Co., 257 Federal Reporter, 849) the United States Court for the Eastern District of Pennsylvania decided that a policy of insurance of a boiler against explosion or rupture did not extend to rupture of a whistle pipe above the whistle valve.

Extending Range of Voltmeter

It sometimes is necessary to measure the voltage of a circuit when there is no voltmeter available having a high enough range. The accompanying diagram shows how a voltmeter having a scale range of less than 220 may be used on a 220-volt circuit, by measuring the drop across two 110-volt lamps connected across the line; then, by adding the readings, the exact voltage of the circuit is obtained.



CONNECTIONS FOR EXTENDING RANGE OF VOLTMETER

The double-throw switch, while not absolutely necessary, renders it easy to take the two readings simultaneously. If the voltage is fluctuating, more accurate results can be obtained by several sets of readings and taking the average of them.

This method can be used for measuring the voltage of any circuit; as, for example, by using 220-volt lamps and a voltmeter having a scale of less than 440 for use on 440-volt circuit. Or if unable to obtain a voltmeter reading of half value, more than two lamps can be used in series and the voltage taken across each lamp.

Readville, Mass. HOWARD M. NICHOLS.

Difference in Heating Systems

Replying to L. B. Shields as to difference in heating systems, page 867, June 3 issue, it is poor practice to inject cold water into vacuum return-mains. If the pump and pipe sizes are correct and the pipe lines are tight and the radiator traps pass no steam, there should be no difficulty in maintaining the necessary vacuum. If cold injection was used as feed water, there would perhaps be no heat units lost, but if it was pumped to a receiver with overflow the lost hot water would mean wasted coal.

I presume the increase in vacuum near the pump was due to leaks from radiator traps being condensed by the cold-water jet. Perhaps the pump could be put in a pit to advantage with a higher vacuum (if there is enough radiator surface), and perhaps it would be possible to get along with exhaust steam only.

New Britain, Conn. WILLIAM DOWNHAM.

Judging from the illustration shown in Mr. Shield's letter, the heating system that he describes is surely a troublesome and wasteful one and I doubt if there was 4 in. of vacuum at the radiators or 8 in. at the pump for half the time. The reason for connecting the returns 8 ft. below the suction line of the pump is not given, but a pump will not satisfactorily lift hot water, as the vapor destroys the vacuum.

In the instance of a thermostatic-controlled system the diaphragm valve at each radiator shuts off the steam and if there is a check valve between the radiators a vacuum is created if there is no automatic air vent. When the diaphragm valve opens again, the steam rushes in to the radiator, destroying the vacuum and causing the system to knock and pound on account of unequal temperatures. If the return from each radiator is connected independently to the main below the pump, then when the diaphragm valve opens the steam rushes through the radiator to the pump, causing more knocking and pounding of the pipes.

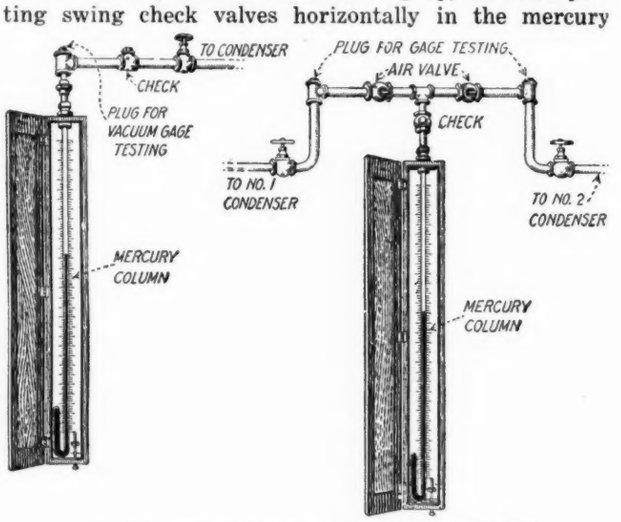
The best way in such a system would be to connect the returns to steam traps in the basement and discharge the traps into a receiving tank placed 6 in. above the suction line of the boiler-feed pump. The cold-water supply should be connected to the tank and its discharge controlled by a ball-cock. If it is a closed tank, connect a vapor pipe from the top of the tank to the roof. The pump should be controlled by a governor, of which there are many types. PATRICK MOLLOY.

New York City.

Check Valve in Mercury-Column Connection

Having seen various kinks published in *Power* and having been greatly benefited by them, I offer the following:

After having had trouble with mercury blowing out of the mercury column when starting up, we tried putting swing check valves horizontally in the mercury



PIPING TO SINGLE- AND DOUBLE-FLOW MERCURY COLUMNS

columns. They operate successfully and help to keep the mercury clean and to prevent water from collecting in the mercury receptacle.

On the double-flow type of mercury column I have air valves which are used instead of globe valves for appearance only. On double-flow column we use one mercury column instead of one for each condenser, and by closing either one air valve or the other we can get the reading of either condenser. HENRY C. SHATZ.

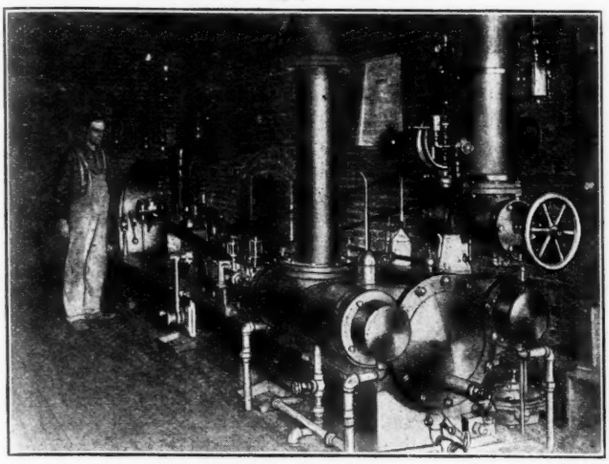
Sinking Springs, Penn.

Oil can be separated from exhaust steam by passing the steam through an oil separator. A separator should not be specified by the size of the engine exhaust pipe, but rather by the quantity in pounds of steam per hour to be freed of oil.

Peculiar Engine Design

At the mills of the White River Lumber Co., Mason, Wis., may be found one of two engines of peculiar design, the only two that are known to be in operation; the other one is at a Washburn, Wis., grain elevator.

The main peculiarity of the engine, which is one of the box-bed type, is th[illegible]eparate piston valves are



AN ENGINE OF PECULIAR DESIGN

used for the steam and exhaust control. The valves are actuated by an eccentric which controls the steam valves, shown at the right in the illustration, and by means of a rocker-shaft and rocker-arm also actuates the exhaust-valve shown at the left.

Upon examining the illustration one wonders why the exhaust connection was not made from the bottom of the valve chamber rather than the top. This engine was installed in 1894 and was second-hand. It has a cylinder 20 x 20 in., and the piston valves are of the inside type. The engine was operated without a governor for several years after it was installed. Later the governor shown was put on. A detachable hook-rod is used so that the engine can be started and stopped by hand.

The main-bearing quarter-boxes are adjustable from both front and back, and the crankpin is put in the crank with a taper and secured in place with a nut.

For some reason both the steam and exhaust barrel chambers are tapped for indicator connections, the connections being shown in the exhaust chamber in the illustration. The cylinder has relief valves on both ends. It is not known who were the original builders of the engine.

L. J. MANN.

Virginia, Minn.

About Licensing Boilermakers

I would like to say a few words regarding compelling boilermakers to pass an examination and secure licenses before they can repair boilers. I agree with C. S. Regan in a recent issue that a better plan would be to allow no repairs to be made until after an examination by a qualified state, municipal or insurance inspector.

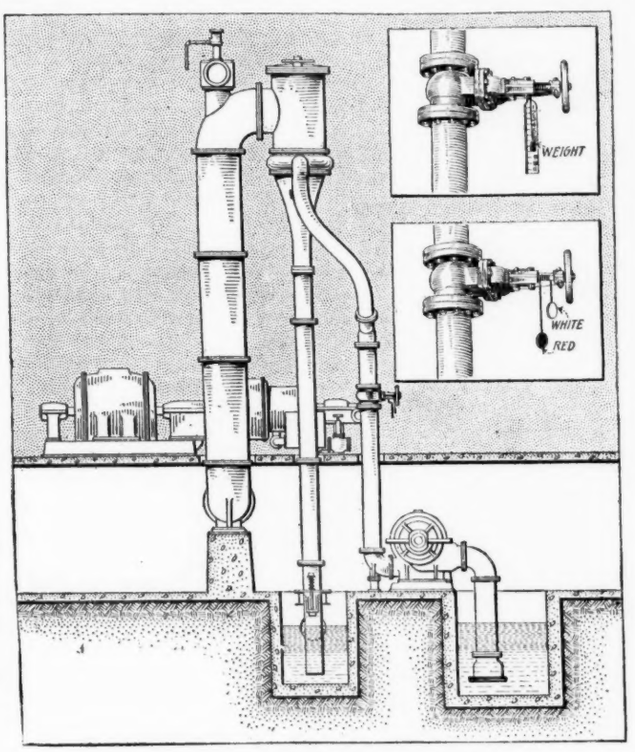
In my experience I have noticed that some of the most expert boilermakers were men who could hardly write their own name. They had no technical education, but had started in as apprentice boys and learned every step of their trade from hard practical experience in the boiler shop. According to my idea one of these mechanics is worth about a dozen of the technical-school men having but little experience.

New York City. S. J. FRANCIS.

Indicator on Injection-Water Valve

A valve was inserted in the injection line of a jet condenser that was used with a turbo-generator. This valve was seldom wide open, but was varied to suit the load, otherwise the condenser would be flooded. The engineers knew by experience the number of turns to take on the valve wheel when starting up and also for the various loads. But this necessitated counting the number of turns, and in the hurry of starting, etc., this method was not always the best. The following idea was adopted to show at all times the amount of valve opening, and it can readily be used in other instances.

The large illustration and top insert show the idea, which consists simply of a cord, one end of which is attached to a weight, the other end being secured to the valve stem by means of a pin. A card, graduated by trial, is affixed alongside of the weight, and the



INDICATORS FOR VALVE STEMS

position of this weight corresponding to the valve opening will at all times be indicated.

A modification of this scheme, to serve as a warning sign as to whether or not the valve is opened, is illustrated in the lower insert. In this case a red disk is attached to the weight and its position hanging below the valve wheel will indicate danger. Another weight, with a white disk, is attached to a cord and secured to the stem so that it will be wound up while the red disk is down and vice versa. This will indicate valve open or valve closed. The disks can be changed to indicate in the opposite manner, if preferred.

Richmond, Va. JAMES M. PURCELL.

Value of Temperature Charts

The accompanying temperature charts may be of interest to readers of *Power* as they are an added proof of the value of recording instruments in determining the conditions which exist at any given point and sometimes are the "evidence in the case" which is necessary to clinch the argument for added instruments, as the following case will show.

The charts shown herewith are reproduction of charts taken under actual running conditions and record the temperature of the feed water entering a battery of boilers of several hundred horsepower.

The source of the feed water is the hot return water from several mills which use the exhaust from the engines for process work, the condensate being returned to an open tank consisting of a cylindrical drum vented to the atmosphere through a 6-in. pipe.

Each mill has its own return tank, the condensate being pumped from the mills to a common return tank located in the boiler house which supplies the mills with steam.

As each return tank was equipped with a water line for introducing cold water and as the amount of water pumped to the boiler plant was under hand control, the boiler house frequently suffered from too much return water at a correspondingly low temperature, the excess passing out at the overflow with a consequent waste of good fuel which cost real money.

The first step in remedying the condition was placing a recording thermometer on the feed line to acertain the temperature of the feed water, and it was discovered that the temperature was much cooler than was generally supposed.

After a short time means were taken to find the cause of the low temperatures, and chart No. 1 was taken as a sample from which to start operations and the following points were noted: The drops in temperature at 11.45 a. m. and 4.45 p.m. were due to shutting down a small coal conveyor engine, but the drop at 5.15 p.m. with a rise at 7.00 a.m. led the writer to investigate running conditions at one of two mills which discharged their condensate to the boiler house through the same line and it was discovered that one mill shut down at 5.00 p.m. while the other one ran the full 24 hours. It was also discovered that the former mill returned its condensate by means of a centrifugal pump, which had no check valve on its discharge pipe, and in shutting down on the day on which the chart was taken the operators had neglected to close the stop valve, with the result that the condensate from the mill which was running had backed out through this centrifugal pump into the sewer instead of going to the boiler house.

A check valve placed in the discharge from the centrifugal pump produced chart No. 2 with a rise of 25 deg. in the average temperature of the feed water, which showed a good saving in coal.

I felt that this chart could be made considerably better if the cold-water valves on the mill tanks could be watched more closely, and by watching the chart and adjusting the cold-water valves chart No. 3 was produced, which shows an average of 208 deg. for the 24 hours, and this was considered to be as good as could be expected with hand control. Having attained this mark and knowing that it is possible to secure this result, the next thought was to devise a method whereby we could maintain the desired temperature automatically, and the solution seemed to lie in something along the line of a thermostat, but it was desired to get the benefit of a 210-deg. feed while the thermostat control was being developed.

With the evidence thus far secured it was an easy matter to secure the purchase of four recording thermometers, one of which was placed on each mill return tank for the guidance of the operating engineer in regulating the cold-water valve, and the investment has proved a wise one. Our feed temperature now averages between 200 and 210 deg. every day, and a method of automatic control has recently been placed in operation which we believe will maintain a uniform feed temperature.

C. B. HUDSON.

Holyoke, Mass.

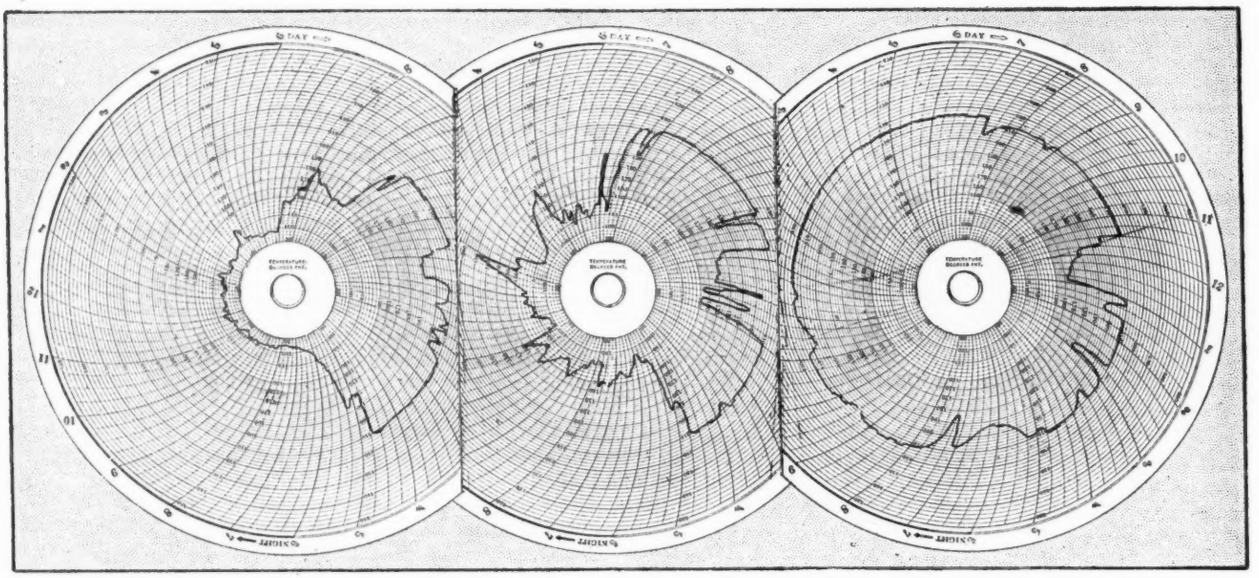
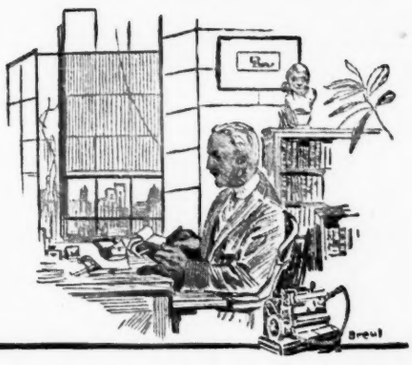


FIG. 1. AVERAGE TEMPERATURE OF 140 DEGREES

FIG. 2. TEMPERATURE AVERAGE 165 DEGREES

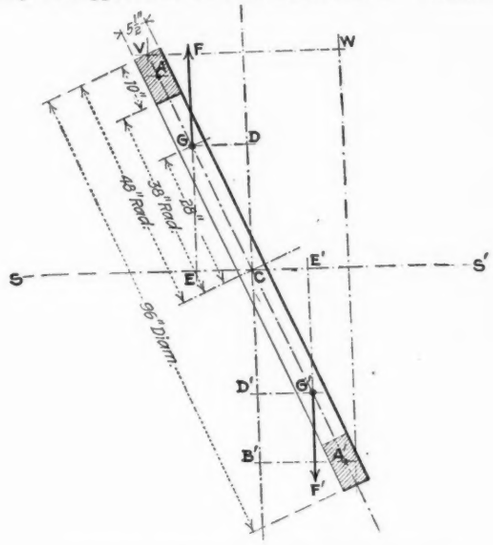
FIG. 3. AVERAGE TEMPERATURE OF 208 DEGREES

INQUIRIES OF GENERAL INTEREST



Shaft Bending Effect of Wobble in Flywheel—The overhung flywheels of an air compressor are 8 ft. in diameter, and one of them has a wobble of ¼ in. The rim is 10 in. deep radially by 5½ in. width of face. Neglecting the weight of the hub or arms, what is the bending effect on the shaft with a speed of 100 r. p. m.? S. B.

Referring to the diagram, assume $S\ S'$ to be the center line through the shaft, $V\ W$ the amount of wobble and $A\ C\ S = A'\ C\ S'$ the angle of inclination of the central plane of the flywheel rim to the center line of the shaft. Then the center of gravity G of the half rim $A\ C$ will rotate in a plane that is a distance $G\ D$ from the plane of rotation $C\ D$ in which G would revolve if the wheel ran true. The weight of the half $A\ C$ may be supposed to be concentrated at G. Rotation pro-



EFFECT OF WOBBLE IN FLY WHEEL

duces a centrifugal effort in the direction of the arrow $E\ G\ F$, which, acting with a lever-arm $E\ C = G\ D$, tends to cast the wheel-half $A\ C$ to the right around C as a center—that is, from G toward D; and there is an equal centrifugal moment tending to carry G', the center of gravity of the wheel-half $A'\ C$ in the same direction *around* the point C,—that is, from G' to D'.

For the given diameter and radial thickness of rim, $C\ G$, which is the radius of the center of gravity of the rim, would be about 28 in., and as the wobble of each half-rim would be ⅛ in. = 0.125 in., then for 28-in. radius we would have $G\ D$ or $E\ C = \frac{48}{0.0125} \times 28 = 0.0729$ in., or 0.006075 ft.

Taking the weight of cast iron as 0.26 lb. per cu. in., one half-rim would weigh $\frac{2}{3.1416}$ [(48 x 48) — (38 x 38)] 5½ x 0.26 = 1931.7 lb.

The radial distance $G\ E$, or distance of the center of gravity of the half-rim from the shaft axis of rotation, would be $\sqrt{G\ C^2 - E\ C^2} = \sqrt{(28)^2 - (0.0739)^2}$, or practically 28 in. = 2.33 ft., and the centrifugal effort in the direction $G\ F$ computed by the formula, *Centrifugal force* = $0.0003408\ W\ R\ N^2$, assuming, W = 1931.7 lb., R = 2.33 ft., and N = 100 r. p. m., would be 0.0003408 x 1931.7 lb × 2.33 ft. × $(100)^2$ = 15,338.9 lb., and that force, acting with a lever arm $E\ C$ = 0.006075 ft., would exert a bending moment around C, which would be equal to 15,338.9 x 0.006075 = 93.183 lb.-ft. from one of the halves or 186.366 lb.-ft. from both halves of the wheel when up to speed, always acting on the same part of the shaft, with a tendency to increase the angle $G\ C\ S$ to 90 degrees.

Engine Piston Leakage—Will a piston leak steam when traveling even though it may seem to be right when blocked and tried; and could there be such a thing as leakage past the rings when changing the direction of travel at the ends of the stroke due to side play of the rings? H. L. K.

It is practically impossible to prevent all piston leakage. The wear of the cylinder is not uniform for the full length of the stroke, and testing the tightness of the piston at one point does not demonstrate its tightness at other points along the stroke. Leakage may be introduced by side slippage of the rings from reversal of the stroke, but this, like leakage shown by blocking the piston at any point, may be only momentary, while the piston is traveling over that particular point, and it should not be taken for granted that the degree of tightness or rate of leakage found with the piston blocked is the rate of leakage during regular operation. The leakage when running will be considerably less than the highest rate of leakage observed with the piston blocked at a point that shows the most leakage.

Amount to Set Up Bearings—How much should the main bearings of a gas engine be set up to allow for lubrication and quiet running? J. O. B.

The amount cannot be generally stated, as in any case it depends on the alignment, material, workmanship, condition of the journal and bearing, viscosity and wearing properties of the lubricating oil, uniformity of supply and distribution of the lubricant, the surface speed and pressure and kind and amount of dirt likely to find its way between the bearing surfaces. Gage the approximate thickness of shims required when the caps are set down hard on the journals with pieces of soft lead wire compressed between the shim surfaces. Try out the setting of the caps with ample thickness of shims and gradually reduce the thickness until the bearings show a tendency to cut or heat.

Cylindrical Tank Capacity in 200-Gal. Intervals—What is the formula for laying off a measuring rod to determine for 200-gal. intervals the content of a cylindrical tank 72 in. in diameter by 25 ft. 4 in. long, laid on its side? J. B.

No general formula can be quoted for the purpose. It is necessary to compute the content for various depths and plot the contents against corresponding depths. Then from a curve drawn through points so plotted, determine what depths will correspond to desired intervals of capacity. The operations are described in an article entitled "Volume of Cylindrical Tanks," by W. W. Ward, *Power*, July 30, 1918, pp 159-60.

Limits of Speed and Capacity of Steam Turbines—Discussion

THE recent New York meeting of the American Institute of Electrical Engineers was devoted to the consideration of the limits of speed and capacity of single-shaft steam turbines and their generators. At the conclusion of the presentation of the three papers, abstracts of which will be found in our issue of Oct. 28-Nov. 4, Calvert Townley, the president, turned the conduct of the meeting over to Philip Torchio, chairman of the Power Station Committee, which had arranged the program. In introducing the discussion, Mr. Torchio said: "It was a little over twenty-four years ago that the New York Edison Company started the operation of the first steam turbine used in a central station in this country at the West Thirty-ninth Street steam station. A week ago the same company put into operation a 35,000-kw. 1500-rev. single-flow machine, which is the largest yet designed for that speed. The machine of twenty-four years ago was a 300 hp., and the present a 50,000 hp.

"This first small unit was a De Laval turbine, built by the French company. After it had been in service for a few years with more or less success, the principal American electrical manufacturers started to build steam turbines. The first American built units were about 500 kw. In 1906 units of 12,000 kw. were built; in 1909 the largest was 14,000; in 1912, 20,000; 1913, 30,000; and in the last year units up to 45,000 kw. 60 cycles 1200 r.p.m. have been built.

"Probably two-thirds or three-quarters of the central station generating equipment today consists of turbo units. When it is considered that the central stations furnish not more than one-sixth of the total power used in the country, aggregating considerably over 100,000,000 hp., and when are further considered such facts as have been brought out by W. S. Murray, that by central-station power generation, of which 93 per cent. is steam and 7 per cent. water, savings in the order of $150,000,000 a year or more can be made on the northeastern seaboard section of this country alone, we are forcibly impressed with the importance of steam-turbine design."

Prophecies

B. A. Behrend, consulting engineer, said that in 1906 he had written "The power station of the future will contain as many 20,000-kw. units as the power station of today contains 5000-kw. units." He ventured twelve years later to go on record that the power station of the future will not contain the 75,000 and 100,000-kw. units of which we have heard a great deal in the papers presented this evening.

Vibratory Stresses

Mechanical stresses as encountered in rotating machinery, like the steam turbine, are not static stresses. They are essentially dynamic stresses, vibratory stresses. A disk may be perfectly safe so far as static stress is concerned, and entirely unsafe because of the dynamic stresses.

The ordinary tempered steel used for disks is very hard and he doubted if such steel, in the form of a disk, could be bent flat on itself, without showing rupture. If it does show rupture, it is unsuited for resistance to vibratory stresses and dynamic stresses.

Learning From Failure

Mr. Behrend's experience with accidents in connection with rotating machinery had not been so varied as that of Mr. Berg. He had had only one accident on a machine of approximately 10,000-kw. capacity. He was sorry, because there is nothing so useful as a failure of that sort in bringing one face to face with facts that we are all unwilling to concede. Failures, in his opinion, should never happen twice, because if they do we have not learned from the first failure what we should have learned by careful examination of all conditions that led up to the failure.

The reference to the limitation of capacity being with the turbine only is, he was sure, incorrect. As Mr. Newbury had explained, with 8 per cent. regulation for noninduction load and 20 per cent. regulation for 80-per cent. power factor load, it was impossible to build larger units. You have to double the regulation losses of your generator in order to double the capacity of your unit, the maximum dimensions being virtually the same in the two types of unit, the electrical dimensions having been altered, because the specifications of the electrical dimensions were changed.

Stresses in End Bell

The rotating end bells are stressed to such a point that it became necessary to thicken them at the ends so as to make it possible to reduce the stresses to a point where it was possible to obtain commercial materials. In 1902 Sir William Armstrong made up the first sample of steel for these end bells. The stresses ran up to 30,000 lb. under normal conditions, and the ultimate stress must be approximately 100,000 lb., ductility determined by an elongation of 20 per cent., and by a reduction of area of approximately 35 or 40 per cent. These end bells, if thickened too much, will make it impossible to put the rotor onto the shaft, and therefore the limitation lies in the length of the air gap and also the depth of the structure.

It is dishonest on the part of engineers who know their business to assert that these end bells are safe. They have not been in operation long enough for us to come to that definite conclusion. We should wait five years until the fatigue of the metal becomes apparent, and perhaps it will not become apparent in five years, and we must wait ten years, and then fractures may occur. He did not say that this was going to happen. He said that vibratory stresses are dangerous, and that we have not had sufficient experience in regard to vibratory stresses to understand them as we should.

The electrical generator is a machine involving such conditions, a feature which it is impossible to gage at this time, because they have not been in operation long enough to enable us to show that trouble from crystallization and vibration is not going to occur at the stresses we have to choose in order to make these machines workable at all.

It has to be considered, as you go beyond certain favorable sizes, that the cost of the machine as well as the charges which must be met in design increase considerably. Another point of utmost importance is the increase in the armature in these machines, which makes the problem of reducing the heating of the stator coils a difficult one. The heat which is troublesome to the designer is the heat produced in the stator coils, as the result of eddy currents. That trouble increases with the increase in the cross-section of the coils. We face the fact that in increasing the capacity of these machines it may become necessary to increase their voltage in order to obtain smaller conductors in which it is possible to reduce the eddy-current losses to such an extent as to make the machines workable at all.

W. L. R. Emmett said that the less work done in a single operation in the turbine, the more perfect the operation; that is, if you put a small amount of work into a stage of the impulse turbine, you can get rather more perfect nozzle action and rather more perfect performance.

No Reason for Very Large Turbine

He was inclined to agree with Mr. Behrend that there is no particular reason for building very large turbines. With turbines of the type that the General Electric Co. builds, such as described in Mr. Berg's paper, there is a distinct disadvantage in going to large sizes, involving low speeds, because on account of the great diameter of the wheels there is a waste of space involved and practical difficulties in diaphragm construction, and varying loads on diaphragms, and the physical structure of the stator becomes excessively large and rather objectionable. The large double-unit machine which has been built by the Westinghouse company, in which the low-pressure element operates at a low speed, is a splendid machine, but these machines are quite large and expensive, and there

seems to be some question as to whether two entirely independent units, each one complete in itself, may not be about as good a solution of the problem, so far as the user is concerned.

He could see a certain disadvantage in running very high bucket speeds in a machine of the reaction type, on account of concentration of the large amount of work in a single blade, and discrepancies in the areas of successive blades. As he had understood or observed the practice of Mr. Parsons himself, he has not gone in for very high bucket speeds in reaction machines. The construction now used by the Westinghouse company is very fine mechanically, and from that standpoint he should say it was very conservative and good, but what its efficiency limitations might be he did not know. He could not agree with Mr. Behrend's generalization on the subject of vibrating and static strains.

Vibrating Stresses Not So Formidable

If we could not calculate upon or predict the nature of vibrating strains, we could not build anything, because almost everything is subject to motion. However, there are pretty definite laws which govern the question as to whether things do or do not vibrate. One of the essentials of sympathetic vibration is the rather perfect state of elasticity, and many structures that are used in motion are very far from that perfection of elasticity which will enable them to vibrate synchronously with any periodic force. Is the shaft upon which a very inelastic load of material is attached an elastic structure? There are laminations upon it, and these laminations make it relatively inelastic. The end bells, which have been described here, are loaded by masses of coils giving very high weight in proportion to the elastic strain on the ring, and also this mass is in itself inducing a condition particularly favorable to dead runnng, so that he would really, without hesitation, put a strain on such rings to the highest possible degree without any fear of their being broken by vibration.

Distortion of Running Disks Made Visible

Periodic motion is the cause, in Mr. Emmet's opinion, of the breaking of certain wheels in General Electric turbines, and some of the possibilities of that situation were beautifully illustrated the other day in Schenectady. They made up two or three wheels out of rubber, some rather thick with heavy edges, and some thinner with light edges. These edges were loaded with little staples hooked through them so as to impose a load in a manner equivalent to that imposed by turbine buckets on wheels. The wheels were marked out like checkerboards, holes put into them, and they were then revolved on a shaft, a contact point upon which was made to actuate a high-potential spark at one point of its revolution, so that the result, running in the dark, was that the wheel apparently stood still with an exact and perfect definition of its markings. The dry skin on the surface of the rubber was even visible upon close examination, and as the wheel loaded up one could see the skin on the surface of the rubber crack and limber itself out into various forms, indicating the distribution of strains around the holes, and the lines drawn on the wheels would be distorted.

This gave a beautiful illustration of the nature of centrifugal strains in such a wheel. That is what it was done for, and they did not expect to find anything else, but in the case of the lighter wheel, when it ran up to a given speed they began to see something else. The edge of the stationary wheel slowly began to work around like a snake crawling slowly through the grass; that is, it would have three or four points in it that would go worming around, and as the wheel was speeded up the snake would travel faster, but not in proportion to the increase in the speed of the wheel, showing that this state of elastic distention had a tendency to equalize itself through a periodic action. If the disk were shaken, it would vibrate in a high period, but the action that he referred to was a slow, deliberate worming around of the edge. At a definite point of diminished speed it would go dead again. They could produce this snake-like motion at higher speeds, and as the wheel was slowed down to a certain limit it would begin to get less and finally stop, and they could not reproduce it without going to the higher speed. Although the stiffer wheels were all very limber, made of rubber, and just a little bit thicker at the edge, they could not produce this effect in them at any speed at which they would stay upon the shaft. The turbine wheel in a state of elastic distention may do exactly the same thing, and instead of going around like a slowly crawling snake it may go at a higher rate of speed, but they do not know.

Slight Stiffening Avoids Vibration

Generally speaking, tendencies to vibration, and particularly tendencies to injury through vibration, diminish very rapidly as the object is made stiffer, because the local strain produced by a certain amplitude of vibration is simply a question of the degree of elongation of the particles on the surface. Their amplitude of motion, their degree of elongation, is very minute, and consequently the strain imposed is very small, and the natural period increased in a normally rapid rate by stiffening the blade and reducing the strain in it at the same time. Consequently, a stiffened disk tends to go dead quite suddenly.

He could not say mathematically as to these limits, but he could say this: The adoption of such light wheels was distinctly against his judgment. They had a premonition of the possibility of such motion several years ago in connection with very large-diameter machines 1200 revolutions, and he had repeatedly warned them to keep the heavy construction on wheels to avoid the possibility of such motion, but there is some difference of opinion as to the cause, and as he does not directly control the turbine designing any longer and this matter rather got away from him, he did not realize quite the extent to which the thing had gone.

The lightening of these wheels was largely a question of the use of a very light method of bucket arrangement which made the rim of much less weight, and greatly lightened the web, and the lack of stiffness in the rim, as well as in the web, would conduce to this tendency to vibration. These rubber wheels showed that it was only with the light rims that they did it. In the case of the wheels with the heavier rims they could not make them distort.

Compound No Better Than Two Separate Smaller Units

Mr. Berg had said in his paper that the generators simply can be made within the limits of the possibilities of the turbine. That applies, of course, to a turbine of the type of which he speaks, but if one made a double low-pressure turbine of the same speed, he would soon get beyond the capacity of the generator, and Mr. Emmet did not think there is very much practical advantage in trying to build a turbine up to the capacity of the generator in that way. A double-flow turbine of the same type could be made of twice the capacity, but it would not be any more efficient and would be quite complicated and large. It might be found necessary to have two generators, and probably would, and he thought it better to keep to a reasonable size and have independent turbine units.

Large General Electric Turbine

W. J. Foster said that Mr. Newbury had asked him to tell of the largest generators that have been built by the General Electric Co. About five years ago there were three 30,000-kw. 25-cycle generators put into operation, one of them a little over five years ago, and two others following closely. These ran at 1500 r.p.m. Since that time there has been one 35,000-kw. 25-cycle, and one of approximately 29,000-kv.a. at 90 per cent. power factor, which has been in operation for one year. There are several 35,000-kw. units now in operation.

In the 60-cycle line there are several 250-kv.a. 80 per cent. power factor, 3600 r.p.m., one 7500kv.a. 6000-kw. 80 per cent. power factor that has been in operation about one year, and they are being built up to 9375 kw., all of these 80 per cent. power factor.

In the 1800-r.p.m. class they had quite a number of 31,250-kv.a. 80 per cent. power factor, and some 33,333-kv.a. at 90 per cent. power factor, 30,000 kw. and are building 40,000 kv.a.'s at a power factor of about 85 per cent. The 60 cycles are all 80 per cent. power-factor machines approximately.

Mr. Newbury's curve, which Mr. Foster thought was an excellent one and scientifically correct, is based apparently on 80 per cent. power factor, and Mr. Foster's experience agreed with Mr. Newbury's statement that the limit is reached in the rotor and not in the stator with these high-speed generators, and that it is all a matter of power factor. If we remove the power factor from Mr. Newbury's curve and draw it upon

a new power-factor basis, it can be raised about 20 per cent., provided the stator is amplified to take care of it. In his experience there is no trouble, with such temperatures as Mr. Newbury mentions, in at once going to 20 per cent. higher output on that curve for a given speed. It has been his experience to design generators for lower temperatures. They are in the 105-deg. class, and not in the 150-deg. class, and that is also true in the case of practically all 60-cycle generators that have been built up to date.

Mr. Foster did not understand why Mr. Behrend considered the matter of eddy current so formidable. It may be impracticable to design a machine so as not to have some eddy current, but there is no need of having them in anything like such quantities as to imperil the life of the machine, or to cause excessively high temperatures.

High Voltages Necessary for High Capacity

The higher we go in capacity the higher the voltage must necessarily become. If we should build 90,000-and 100,000-kv.a. generators, it would be very difficult to build them in less than the highest voltages that we are now building generators for 30,000 volts. He thought it would be possible with 1200 r.p.m. by new equipment, but not making such a radical change as we made six or eight years ago, when we stepped up to 30,000. It may be possible at the present time to build 90,000-kv.a. 1200-r.p.m. machines. Mr. Foster thought that radical ventilation presented greater possibilities. The larger size of radial ventilation involves larger surfaces for the cooling media to remove heat from the iron and from the windings, the coils being exposed at short intervals, large areas of them exposed to the air, and then such a large surface of the core itself that heat removal is far more effective than in anything he could conceive of as practicable in axial ventilation. The holes for the air to pass axially cannot be right in the teeth, nor very close behind the teeth, except at the core surface. If the area of the holes is figured, it will be found extremely small in comparison with the area that surrounds the two sections for radial ventilation.

Alexander M. Gray, in discussing Mr. Newbury's paper, gave a summary of the design of a 70,000-kv.a. single-shaft machine with a rotor 51 in. in diameter, operating at 1800 r.p.m. Mr. Gray pointed out that the rotor diameter in such a machine is limited by the hoop stress in the end-connection retaining rings, and not by the disk stress. The stress in a coil-supporting ring 51 in. in diameter, due entirely to its own weight, is 15,000 lb. per sq. in. In addition to this it must support the ends of the coils. The maximum rotor excitation is limited to about 1000 ampere turns per pole per inch of rotor diameter, or 51,000 for a 51-in. machine. Machines are in operation with the stator ampere turns per pole as large as 0.6 maximum rotor excitation. This would limit the rotor excitation of the 51-in. machine to 30,000 ampere turns per pole. Operating the stator of such a machine at a tooth density of 100,000 lines per square inch, the machine will be capable of developing about 450 kv.a. per inch of iron. Axial length of the rotor is limited by alternating bending stresses in the bearing journals. With the bending stresses limited to 5000 lb. per square inch, the length of the rotor between bearings will be 310 in., and the effective length of the rotor will be about 230 in., making the output about 70,000 kv.a. In his closing remarks Mr. Gray said: "I do not suggest that a machine such as the foregoing should be built. There will be undoubtedly manufacturing trouble, due to the length of coils, and also trouble due to movement between conductor and insulation, because of the increase of length with increase of temperature. It is possible to reduce the length of the machine, and the various factors in the above summary are open to attack."

R. B. Williamson, in his discussion on Mr. Newbury's paper, considers the mechanical considerations are equal to, if not of greater importance than the electrical features in the single-shaft turbo-alternator, and since the two are more or less antagonistic to each other, the design as a whole must be a compromise. In the high-speed machine the maximum output is limited by the rotor, while in large slow-speed machines the stator becomes the limiting factor. Mr. Williamson agreed with the author of the paper that a peripherial speed of 400 ft. per sec. is as high as it is advisable to run a carbon-steel rotor, but if rotor cores are made of alloy steel, higher stresses might be allowed, and a larger limiting output obtained. Steel of the latter kind, when used in large masses, is very liable to develop cracks, and at present is not reliable for the purpose. Mr. Williamson called attention to the output of 10,000 kv.a. for machines operating at 3600 r.p.m. as being something that so far has not been accomplished, although machines of 7500 to 8000 kv.a. are in regular commercial service, but that if it were considered desirable from the steam end of the unit there is little doubt but that it will be possible to design a support for a 10,000 kv.a. 3600 r.p.m. rotor.

Francis W. Hodgkinson asked, "Why should not any of the turbines which have been described have their diameters increased little by little, more length of blades, and have their capacity increased in proportion? There is no reason why not. Why is it not done? Principally because of personal judgment as to where stresses, etc., should cease, not necessarily the calculated stresses, the centrifugal force, but these obscure things that Mr. Behrend spoke about.

"There can be no definite lines drawn as to what stresses you should put any given materials to or what chances you should take. Sometimes some of us are in rather unfortunate positions, and have pressure brought upon us, and must use our best judgment and then go a little further because of that pressure. Mr. Behrend touched on some real truths. He referred to a turbine built by competitors of the company that I represent, but I venture to say that none of the disks would stand the abuse that Mr. Behrend pointed out. I believe they would bend over. What has that to do with any vibratory stresses continually going on there, which, if slightly above the elastic limit, must result in rupture?" He did not want to be understood as saying that the vibrations do that, but the bending stresses he did not think were of so much importance as Mr. Behrend thinks they are.

Mr. Emmet referred to a power station in which single units were employed as compared with cross-compound units. Mr. Hodgkinson had personally favored these cross-compound units, for the reason of simplicity. A turbine working with high pressures at one end and low vacuum at the other calls for skill in designing the distribution of the metal so that expansion and contraction shall be uniform and no distortion result, and any simplification of the circuit is an advantage. By cutting the steam cycle in two, also cutting the temperature range in two, there is a distinct simplification. Many people regard it as a redundancy because there are twice as many bearings. Bearings do not give any trouble, but the simplicity of the circuit does mean something, and in order that different speeds may be employed you can prepare a design of turbine wherein the high-pressure element will run at one speed most suitable to it, and the low-pressure element can run at the most suitable pressures of steam that are involved

Heat-Treated Alloy Steel Disk Not the Safest

B. G. Fernald said that the limit of stress to which the rotor material is subjected in Mr. Johnson's paper is 20,000 lb. per sq. in. when operating at a speed 20 per cent. in excess of the normal. The elastic limit of the material which he uses is about 22,000. Mr. Berg brings out the fact that the maximum stress in the hub and web of his rotor wheels is now 23,000 and 23,500 lb. respectively, and he uses a nickel-steel disk quenched and tempered—in other words, heat-treated—which shows an elastic limit of 55,000 pounds.

On the face of it the element of safety would seem to be with the heat-treated alloy steel disk, but for reasons given by Mr. Berg that is not the case. He wondered if anybody had had an experience that would enable him to tell if a disk of such sizes as are here contemplated can be heat-treated so that one knows when one gets through that the disk is free from shrinkage stresses.

B. A. Behrend said that the reason for a test of the durability of the material, and vibratory stresses, is that vibratory stresses need not be resonant stresses. Vibratory stresses are all stresses which change in direction. If resonance occurs freely, there will be rapid distortion. Where there is no resonance, the period may be extended from five to ten years.

Comfort A. Adams said that Mr. Behrend might be cheered to know that a very elaborate series of fatigue tests is now being started, on which it is expected to expend $40,000 a year for three years. They are being carried on by the University

of Illinois under the Engineering Division of the National Research Council. Mr. Adams thought that Mr. Behrend, in pointing out the dangers of vibration, had spread the danger over a rather large field and without sufficient discrimination. What he says about synchronizing or nonsynchronizing of force and free vibration is quite true, but there are few forced vibrations in the turbine, properly balanced and properly centered, which involve stresses beyond the elastic limit.

Fatigue Stresses Not Dangerous if Within Elastic Limit

It has been assumed that if fatigue stresses are within the elastic limit they are not dangerous. The real dangerous stresses in a disk of this sort are not those due to forced vibration, but are those that synchronize with the natural period of the disk. A very little change in the design, or a slight thickening of the disk, may make all the difference in the world. The danger of rigidity or brittleness as distinguished from these defects may be a safeguard. In so far as the danger is increased with this brittleness, it may change the period of vibration and bring one into the safe realm, rather than into the danger realm. It is possible that the ductility itself may be a source of danger, provided it is accompanied by that increase of elasticity which will cause the vibration to hit the natural period, so that it is a danger which can be spread in a generous way over the whole landscape without discriminating,

Mr. Emmet called attention to the fact that the stresses mentioned in Mr. Berg's paper, of between 20,000 and 23,450 lb., were upon steel having an elastic limit of 55,000 lb. per sq. in. and a tensile strength of 105,000 lb. per sq. in. This is an exceedingly ductile nickel steel, and the stress is a very moderate one. In connection with the matter of vibration, he said that one must have elasticity. The point that he had before made was that if you have a mass of copper below the rings and the mass of copper is extremely dead, the ring cannot vibrate without the copper vibrating.

Farley Osgood said that he had not heard very much said from the operator's standpoint in this situation, and that the poor operators apparently are the victims of the enthusiasm of the designers. It gave him some consolation to hear less talk of 50,000-and 70,000-kw. units. Most of the writers of the papers had confined their enthusiasm to approximately a 30,000-kw. limit as to design.

Continuity of Service

The limiting feature from the standpoint of the operator is, of course, continuity of service, but the success of the designer now makes continuity of service fairly good. Failures are unavoidable in some cases. That means to the operator the loss of the use of the machine. It also means to the operator not only loss in capacity, but loss in the time of use of his machine, and he thought limitations as to size should have that thought as a factor. The writers of the papers bring out quite clearly that very large designs require special tools, special men, and generally factory work when repairs are necessary, which means long delays when these repairs have to be made. He would suggest, from the operator's standpoint, that no design should be made which would require perfection in materials which would in any way lead beyond the point of practical manufacture of such materials, that they should not lead to a point requiring special treatment, so that the product when complete is virtually a special product. The sizes should be confined to such as can be cared for quickly in times of repair and should not be so great as to require enormous investments for spare capacity.

He thought that the manufacturers of these large and costly units know less about their behavior in operation than any group of men in the electrical business. The designer should come and visit the operators. His company was typical of the purchasers and users of large units, but the designers of the two principal companies which manufacture those units have, within his knowledge, spent no time on their property to see how their offspring behaved.

Mr. Johnson, in closing, said, in reply to an intimation that there was greater leakage with the reaction type, that there is practically no difference between the two designs with regard to leakage. In the one type of machine you have a small clearance on the outer diameter, across which the steam may leak, but the pressure difference on opposite sides of a given row of blades is small, so that the steam velocity through it is very slow, whereas on the other type of machine the diameter is smaller, but the pressure difference is greater, and consequently the quantity of steam going through a given area of leakage space is greater. In their 1800-r.p.m. machine of the larger size, which has blades 18 in. in length, the leakage across the last-row figures about 1 per cent., which is practically the same as with the impulse type of machine. He knew of no reason why the reaction type could not be built with the last row of blades operating at the same speed as an impulse type. If you please, you may use the exact construction, changing, perhaps, only the shape of the inlet portion of the blades, and then build a reaction machine from there on up, instead of the impulse machine. The limitation characteristics will be the same. In fact, any impulse machine must of necessity operate as a reaction machine in the last stage if the vacuum becomes sufficiently high to cause a pressure drop through the blades.

Mr. Berg said that the wheel which he had assumed was a very conservative one; the elastic limit there given as 55,000 lb. is about as low as they had ever found in actual test. The majority of the wheels test at 65,000 lb., and they had wheels running at 1800 r.p.m., which were 100 in. in diameter, instead of 88 in.

Mr. Newbury said that he was familiar with the multiple-inlet type of radial ventilation mentioned by Mr. Foster, and in fact had that in mind in the last sentence of the paragraph on ventilation, in which he said: "But with either system of ventilation designers are already finding it necessary to devise more complicated systems in order to take care of 3600 and 1800 r.p.m. rating now in prospect." The Westinghouse company uses both types of radiation, and the same machine can be designed for either type with substantially the same radiating surface. The two machines will be somewhat different in proportion. The radially ventilating machine will be of smaller outside diameter and longer in the core. The axially ventilated machine will be shorter in the axial direction, but will be of larger outside diameter. Mr. Foster was correct in assuming the curve of limiting generator capacities at various speeds to be based on 80 per cent. power-factor machines, and what he said in connection with 100 per cent. power-factor ratings is correct.

Domestic Exports of Pumps and Pumping Machinery, September, 1919

Countries	Dollars	Countries	Dollars
Belgium	19,177	Argentina	13,154
Denmark	3,659	Bolivia	532
France	18,793	Brazil	4,757
Greece	1,560	Chile	14,887
Italy	2,480	Colombia	2,604
Netherlands	24,533	Ecuador	796
Norway	672	British Guiana	4,245
Roumania	29,434	Dutch Guiana	130
Spain	10,224	Peru	10,795
England	55,583	Uruguay	4,284
Scotland	365	Venezuela	2,522
British Honduras	489	China	39,572
Canada	208,325	British India	17,548
Guatemala	1,034	Straits Settlements	100
Honduras	695	Dutch East Indies	14,797
Nicaragua	463	Hongkong	568
Panama	4,588	Japan	27,814
Salvador	34	Russia in Asia	231
Mexico	95,669	Australia	10,553
Miquelon, Langley, etc.	67	New Zealand	11,482
Newfoundland and Labrador	684	French Oceania	175
Barbados	89	German Oceania	13
Jamaica	2,024	Philippine Islands	27,437
Trinidad and Tobago	133	Belgian Kongo	100
Other British West Indies	280	British West Africa	70
Cuba	87,579	British South Africa	12,780
Danish West Indies	837	French Africa	5,486
Dutch West Indies	1,928	Portuguese Africa	1,330
French West Indies	7,008	Egypt	581
Haiti	473		
Dominican Republic	9,126	Total	817,348

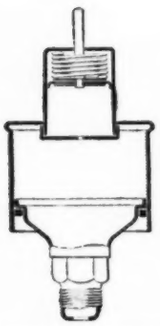
Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Cup, New Standard Duplex Grease

Standard Manufacturing and Sales Co., 1325 Arch St., Philadelphia, Penn.

"Power," Sept. 16, 1919

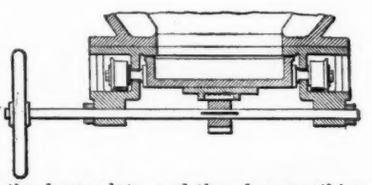


The cup is in two parts, with a diaphragm between, in which is a small hole through which the grease passes into and out of the top portion of the chamber. This contains a spring-actuated plunger, with a stem which protrudes from the top and serves as a sight-feed indicator. The plunger is acted upon by a spring pressure above and the grease pressure below, the grease moving in the direction of the stronger force. The lower portion of the cup is filled with grease and screwed down on the base. The fluid pressure thus created drives grease through the diaphragm, raises the plunger and sets the indicator, and at the same time forces grease through the shank into contact with the bearing. As the grease is used up, other grease automatically takes its place.

Ashpit Gate, Arrow

Baker-Dunbar-Allen Co., Pittsburgh, Penn.

"Power," Aug. 26, 1919

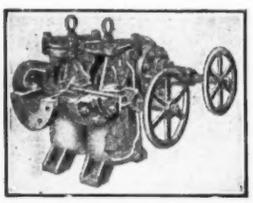


This ashpit gate is made of heavy cast-iron sections having cast-iron rollers. The gate operates on lubricated bearings and is made in sizes that will take care of any openings from 18 in. square to 3 x 5 ft. This permits the opening in the hopper to be made larger than the opening in the dump plate, and therefore anything that passes the dump plate will pass through the hopper. The gate closes against machine metal surfaces and automatically compensates for wear. It is lined with brick and may be hand, motor or piston operated with air, water or steam.

Strainer, G-R Duplex

The Griscon-Russell Power Co., 90 West St., New York City

"Power"

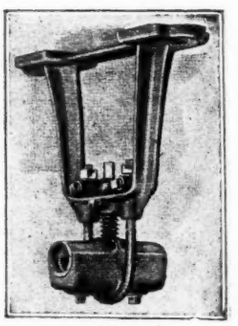


This strainer is designed for installation in the suction or discharge lines of lubricating or fuel-oil systems for the removal of solid foreign material in suspension. It is also suitable for straining river and pond water supply. It consists of a cast-iron body containing two perforated-steel or brass baskets. A valve arrangement permits of the removal and cleaning either basket while the other remains in service. Oil or other liquid enters the inlet connection of the strainer and passes into the basket in service. The solid matter remains in the basket, the clean liquid passing through the perforations thence out of the strainer. All cast-iron sections are cylindrical. The valve mechanism is simple and the valves are easily reground.

Hangers, Barry Shafting

Barry Co., Muscatine, Iowa

"Power"



The main feature of this hanger is that the bearing is suspended from a hanger frame by a loop, the two ends of which are threaded. The hanger has an adjustment of 2 in. which is conveniently made by the nut shown and the adjusting screws. One of the features is that headroom is saved, owing to the compactness of the design. The loop is made of cold-rolled steel. These hangers are made in drops from 7 to 29 inches, and with self-oiling bearings from $1\frac{1}{2}$ to $3\frac{13}{16}$ inches.

Pump, Fulflo

Fulflo Pump Co., Blanchester, Ohio

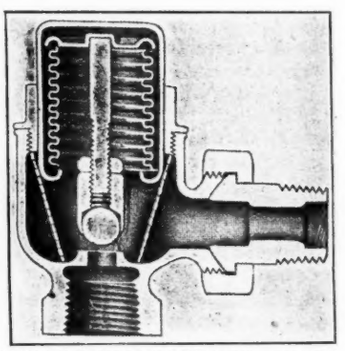
"Power"

This is a reversing centrifugal pump. The reversing action is accomplished by the design of the volyte and the incorporation of a gate in the discharge, which deflects the water as the pump is reversed from one direction to the other. The gate and the pin on which it is mounted are of bronze, thus eliminating corrosive action. The pump can be run in either direction and can be reversed from one direction to the other, giving instant flow of the liquid being pumped upon starting the pump or reversing the direction. The pad for mounting the pump to the machine base is detachable and can be placed in any one of three positions.

Trap, Sarco Radiator,

Sarco Company, Inc., Woolworth Building, New York City

"Power"

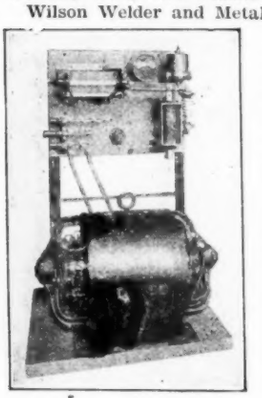


In this trap a spirally corrugated tube with the outer case forms an expansion chamber, which contains a volatile liquid. The inside of the diaphragm is exposed to the steam or vapor resulting in the quick and wide opening and closing of the valve. A strainer is provided to prevent clogging of the valve, and protects the valve head and seat. The strainer has a discharge area about ten times that of the valve itself. The valve will work on any degree of vacuum and on any steam pressure up to 20 lb. per sq.in. without readjustment.

Welding Unit, New Plastic

Wilson Welder and Metals Co., 2 Rector St., New York City

"Power"



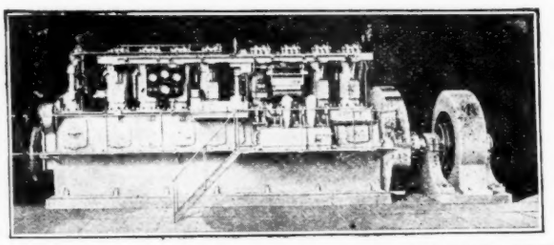
This set is composed of a dynamotor and current-control panel. Generator, flat-compound wound, 35 volts on either no load or full load. The control panel is designed to provide a constant-current controlling panel, small in size, of light weight, simple operation and high in efficiency. On the 20 x 27-in. panel are mounted a small carbon pile, a compression spring and a solenoid working in opposition to the spring. The solenoid is in series with the arc, and any variation in current causes the solenoid to vary the pressure on the carbon pile, thereby keeping the current constant, at the value of adjustment. This outfit is furnished as a dynamotor unit, with standard motor characteristics as follows: 110-220 volts, d.c. or 220-440 volts 60 cycle two or three phase a.c., also as a gasoline-driven unit.

Engine, Winton Oil

Winton Engine Works, Cleveland, Ohio

"Power," Sept. 16, 1919

Diesel type now built for stationary service or direct connection to generators, pumps and also for belt drive. It is built in three sizes with three, four, six and eight cylinders, developing from 50 to 450 hp. Inclosed crank cases, trunk-type piston and crankshaft bearings mounted in the upper half of the crank case with bolted-on cap are the chief characteristics of this engine. Fuel is delivered with a pressure of from 1000 to 12000 lb.



Patented Aug. 20, 1918

Annual Meeting of the American Society of Mechanical Engineers

THE annual meeting of the American Society of Mechanical Engineers, held in New York City, Dec. 2-5, 1919, was especially successful from the standpoint of attendance, there being about 1250 members and 800 guests registered. This record of over 2000 is the largest attendance at any meeting, and is an indication of the interest which is taken in the society.

Headquarters and the Registration Bureau were opened at 9 o'clock on the morning of Tuesday, Dec. 2, and the morning and afternoon were taken up with meetings of the Council and various committees.

At 8:30 p. m. the formal sessions were opened in the Auditorium of the Engineering Societies' Building, with the presidential address by M. E. Cooley. President Cooley's address was a description of the mechanism of organization of the society. He reminded the audience that he, himself, previous to taking office, had been largely unfamiliar with the methods of the organization and assumed that the majority of the members were equally uninformed. The affairs of the society are managed by the Council consisting of the president, six vice presidents, nine managers, the treasurer, and the five surviving past presidents who last held office. President Cooley called attention to the large amount of work required of the members of the Council and expressed warm appreciation of the unselfish way in which they had devoted themselves to this work. There are a number of standing committees to carry on certain continuous functions of the society as well as special committees appointed for special work as need arises. There is a paid secretary with a numerous force of assistants to help in the work of his department. President Cooley remarked that if the members in general knew how far the positions of officers and committee members were from purely honorary jobs, there might be fewer candidates for office.

At the close of the address the tellers of election reported that the Society had elected the following officers for the year 1920: President, Fred J. Miller; vice presidents, John R. Allen, Robert H. Fernald and Edward C. Jones; managers, Elbert C. Fisher, Dexter S. Kimball and Earl F. Scott, and treasurer, William H. Wiley. In this connection it is interesting to note that Major Wiley was elected treasurer of the society in 1884 and has been regularly renominated and reelected to this position each year since.

After the announcement of the election Major Miller, the president-elect, was escorted to the platform and formally introduced to the members and guests.

Announcement of the Election of Honorary Members

The constitution of the society provides for honorary membership which shall be conferred after a unanimous vote of the Council on persons of acknowledged professional eminence. This is considered the highest tribute the society can confer on an engineer, and the number of honorary members is limited to twenty-five at any one time. James Harkness was given the floor and announced that the Council had elected to honorary membership, M. Charles de Freminville, consulting engineer, Creusot Works, France. Mr. Harkness told of having known M. de Freminville at his home in Paris, during the bombardment of that city by the long-range gun, and of how he had been affected by M. de Freminville's wonderful spirit under those trying times. After President Cooley had formally delivered the certificate of honorary membership M. de Freminville responded, calling attention to the close relations between the engineers of his country and those of our own. Fred R. Low announced that the Council had also elected M. Aguste C. E. Rateau, chairman of the board of directors, Rateau, Battie & Smoot Company, France, to honnorary membership, in honor of his important work in the development of steam turbines and the flow of fluids in nozzles. Mr. Rateau was not in this country so the certificate of honorary membership was handed to M. De Freminville, who promised to deliver it to M. Rateau for the Society.

After the close of the exercises a reception was held for the ladies, members and guests.

On Wednesday morning a business meeting was held. Reports were received from standing and special committees. The report of the Finance Committee showed a total income for the year ending Sept. 30, 1919, of $333,000 in round numbers, or an average of $32.64 per member, based on a membership of 10,200 (the average of the total membership on Oct. 1, 1918, and that on Oct. 1, 1919). The budget appropriations recommended by the committee for the year 1919-20 is $383,000.

The report of the Committee on Meetings and Program noted the constant growth of the spring meetings as an indication of the growing influence of the Society and the hope that the plans for the annual meeting would result in another record-breaking attendance. How well this hope was realized is shown by the attendance figures already quoted.

Report of Committee on Aims and Organization

The Committee on Aims and Organization had presented a preliminary report at the 1919 spring meeting in Detroit and now presented a final report as a result of the discussions at that meeting. Its recommendations were grouped under three headings.

The principal recommendations concerning Society Activities suggested that the Society should adopt a policy of establishing engineering standards and that the constitution be amended to allow such adoption. For help in preparing such standards the Society should increase its interest in research by appropriating more of its own funds and by obtaining funds from other sources, also by formulating problems and securing men and facilities to solve them. The standards adopted should be regarded as progressive, not final standards.

In the matter of education and special training the work in the higher-grade technical schools was approved, but the suggestion was made that much should be done in connection with industrial education below the grade of college work.

The committee persisted in its recommendation that *Mechanical Engineering*, the official organ of the Society, be published weekly. This was objected to at the spring meeting, mainly on financial grounds.

The adoption of a short code of ethics of broad scope, general character and positive rather than negative was urged and it was suggested that a committee be appointed to prepare such a code and report back to the Society.

Other recommendations concerning the details of society organization were made.

The second heading contained recommendations for the formation of a national organization through which the coöperation of local groups, state groups and national societies can be secured for purposes of national scope. Accompanying this report is the report of the Joint Conference Committee representing the four national engineering societies on a national organization. In line with this report the committee insisted on its original recommendation that the national organization should be an independent body.

Under the third heading concerning activities of this national organization the following activities were recommended:

The promotion of legislation for the protection of health, life and comfort, for the development and control of national resources and public utilities and for registration and certification of engineers whose work involves the public well being. The establishment of standards for the production, sale and distribution of commodities. The use of all proper means to secure the appointment of the highest grade men to public engineering positions and close coöperation with such men. The collection of data to help in the selection of engineers to meet public emergency. A dignified campaign of education, in the public press, along engineering lines. Active participation in the solution of the present industrial problems.

Later in the meeting the amendments to the Society's constitution, designed to carry out the committee's recommendations,

were ordered to be balloted on the first day of March, 1920.

The Committee on Local Sections presented a very comprehensive report covering the five years of its existence. This committee was organized in 1915, at which time there were only eight local sections, the first two of these, St. Louis and Boston, having been established in 1909. As a result of the activities of the committee and the enthusiasm of the local leaders there are now 31 sections of which one is a state section with five branches, making a total of 35 active A. S. M. E. centers. Coincident with this growth the annual appropriations for local sections have increased from $3500 in 1914-15 to $23,000 in 1919-20. The work of the local sections in the direction of closer affiliation with groups of other branches of the engineering profession is looked upon as an important factor in the development of a national organization as described in the report of the Committee on Aims and Organization.

The Boiler Code Committee presented a preliminary report on Rules for the Construction of Boilers of Locomotives,

MEMORIAL TABLET TO FREDERICK REMSEN HUTTON IN THE ROOMS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

which are not subject to Federal inspection and control. This report, when adopted, is to be incorporated in the Boiler Code as Part I, Section III, Locomotive Boilers.

Following the reports of committees, announcement was made of the awards of the Junior and Student prizes for papers contributed by members in these two classes. The prizes to Junior members of $50 and diploma were awarded to E. G. Whalen for his paper on "Properties of Airplane Fabrics," and to C. F. Leh for his paper on "An Experimental Investigation of Steel Belting." Mr. Leh's paper was presented jointly with F. G. Hampton who received a Student prize of $25 and diploma. The other Student prize went to W. E. Helmick for another paper on the same subject as that of Mr. Leh and Mr. Hampton.

Unveiling of Hutton Memorial Tablet

Past President W. R. Warner formally unveiled a memorial tablet to be placed in the Society's rooms as a tribute to Frederick Remsen Hutton, who was secretary of the Society from 1883 to 1906, president in 1907 and honorary secretary from 1907 until the time of his death, May 14, 1918. Mr. Warner emphasized the great value of Professor Hutton's services to the Society in its early days. When Professor Hutton first became its secretary, which then meant its active director, the Society, only three years old, had about 400 nominal members, of whom probably less than 100 were effectively active in its affairs. When he gave up the office of secretary, 23 years later, the membership was ten times greater. The financial affairs were in such condition that initiation fees had been treated as current income. The Society headquarters were maintained in Professor Hutton's study at Columbia University. His efforts, ably supported by the stanch founder members, resulted in such growth and prosperity that in 1890 a house at 12 West Thirty-first street was purchased for $60,000. The financing was left to a committee of three, of which Professor Hutton was one. Later he was a member of the joint committee appointed to carry out the generous intention of Mr. Carnegie to provide a necessary building for the use of the several engineering societies.

After his graduation from the School of Mines, Columbia University, he became an instructor in mechanical engineering at Columbia and rose through various steps to be Dean of the Schools of Applied Science in 1899. It was during these years of hard work as a teacher that he found time for his numerous services to the Society. Many expressions from his associates indicate a belief that the success of the Society in those days when it was struggling for existence is due more to Professor Hutton than to any other man.

A memorial pamphlet was presented to the meeting as a tribute to William Kent, who died Sept. 18, 1918. Mr. Kent, who is best known as the author of "Kent's Mechanical Engineer's Pocket Book," was a charter member of the Society. He was for years an active consulting engineer, paying particular attention to boiler and furnace work.

A report of the Committee on the War Activities of members was presented by Major Miller, the president-elect. Major Miller paid tribute to the efforts of the 1400 members of the Society who served in the Army and Navy, especially those who gave their lives in this service.

Wednesday Afternoon Professional Session

On Wednesday afternoon were held the first professional sessions. One of these was devoted to Appraisal and Valuation, which was held jointly with the American Society of Refrigerating Engineers. A second session at the same hour was devoted to Gas Power. Four papers were presented: "The Hvid Engine and Its Relation to the Fuel Problem," by E. B. Blakely; "Kerosene as a Fuel for High-Speed Engines," by L. F. Seaton; "Combustion of Heavy Fuels in Engines of Constant-Volume Type and Super-Induction Engines," by Leon Cammen; and "Oil Pipe Lines," by S. A. Sulentie. The first three papers will be published in abstract form in early issues of *Power*. It is of interest to note that these three papers all dealt in some form with the problem in internal-combustion engines of small size. In Mr. Sulentie's paper the author compares the cost of pipe-line transportation with that of rail and canal transportation and shows the advantages of the oil engine for pumping the oil. He also derives simple formulas for rapid calculations of the pressure and power necessary for such pumping.

A third session was devoted to the problem of industrial unrest and after considerable discussion this session voted to ask council of the Society to appoint committees on the following subjects:

Investment Savings, Credit Capital, Organized Labor, Employees, Managers, Economic and Production Intelligent Service and Committee on the Efficiency of Productivity.

The activities of such committees are intended to crystallize the work already done by the Society on these lines. The wording of the declaration of principles on which this action is being taken is as follows:

"Every important enterprise must adopt competent productive management, unbiased by special privilege of capital or of labor, and disputes must be submitted to authorities based upon intrinsic law.

"Credit capital represents the productive ability of the community and should be administered with the sole view to the economy of productive power; that is, should be granted only to those who are able to render valuable service."

It is believed that this initiative which is unique in the history of professional organizations will have an important influence in fully bringing the facts of the labor situation before the American people.

At 8:30 p. m. a meeting in commemoration of the eightieth anniversary of the meeting of Cornelius De Lamater and Captain John Ericsson, their fifty years of service to this country and the thirtieth anniversary of their deaths. This meeting was the joint effort of fifteen technical societies and civic organizations. Lewis Nixon, public service commissioner of New York, presided. H. F. J. Porter gave an illustrated review of the work of the two men in the De Lamater Iron Works. Mr. Porter told of the meeting of the two young men, of their close friendship and recounted many instances of the growth of the Iron Works. The De Lamater Iron Works was the successor to the Phoenix Foundry, and here were built, largely under the direction of Captain Ericsson, the first iron boats and the first steamers driven by screw propellers, also the engines of the "Princeton," the first United States frigate with engines and boilers below the water line. Much other important work was done here and such naval equipment as self-propelled torpedoes, torpedo boats, submarine boats, etc., were initiated and developed in this plant. The engines of the famous "Monitor" were also constructed here, and rock drills, ice machines, etc., were first made under the direction of these two men.

Following Mr. Porter's address the Hon. C. H. Vezin, Jr., a grandson of Mr. De Lamater, paid a tribute to the memory of his illustrious ancestor, whom he described as a real autocrat in his business, but withal so fair and just that he was respected and loved equally by his associates and employees. The next speaker was the Swedish Minister to Washington, W. A. F. Ekrengren. After outlining Captain Ericsson's achievements and distinguished services in the United States, the speaker said: "While John Ericsson was always faithful to the country which he had chosen as his and did not hesitate to offer her his services and his life, he loved and honored his mother country, Sweden, and never failed to render it a service when he was able to do so. His "Monitor," which he invented long before it came to practical test, was intended for the coast defense of Sweden, and when the first ship of this type was built for the Swedish Navy, he presented to the Swedish government armament for it."

The concluding speaker was Rear-Admiral Bradley A. Fiske, U. S. N., retired. He pointed out the superiority of Ericsson's "Monitor" over the "Merrimac" and that this meant not only that the North would be able to maintain a blockade against Confederate vessels of war, but that it could prevent aggressive action against our country by the most powerful European navies. Mahan's famous book on the "Influence of Sea Power on History" had not then been written, and the attention of the North was so fixed on the movement of armies that the weak point of the Confederacy, its sea communications, was not appreciated and was not attacked vigorously enough. Ericsson's advice was disregarded and much effort was wasted in fighting large, bloody land battles which had no decisive results toward winning the war. Despite the failure to follow it up to the best advantage, Ericsson's "Monitor" undoubtedly turned the critical situation in favor of the North and had an inestimable effect on the history of this country and of the world.

Thursday Morning Session

On Thursday morning, Dec. 4, the session was devoted to "The Industrial Situation in Relation to Present Conditions." The principal paper was by Frederick P. Fish, chairman of the National Industrial Conference Board. Mr. Fish called attention to the need of the utmost efficiency in production and distribution at this time and to the unfortunate lack of harmony in the relations between management and wage earners. As an example of decreased productive power he said that in one plant he found that wages had increased 110 per cent. since 1914, although the cost of living has not gone up more than 75 per cent. and the efficiency of the individual workman has been reduced 40 per cent. in the same period. Mr. Fish criticized the labor unions for their attitude in arbitrarily limiting production, in enforcing the same rate of producton by the good workman as by the poor one and in insisting on dictating their own terms, which were often framed for the benefit of the union and against the interests of the workmen, the employers and the community at large.

He also criticized the management for lack of attention to the proper relations with employees and to employees' working conditions. The same instinct on the part of the public which brought about the more or less warranted attacks on big business twenty years ago will bring about a similar recognition of the danger in the improper exercise of power threatened by the labor unions. If public sentiment is once aroused, the end is certain. The American people will not submit to the domination of any class working solely in its own interest.

The remedy, the speaker asserted, lies in some form of closer relations and better understanding between employees and management. Just how this is to be accomplished must be worked out for each individual plant, as no two present exactly the same problem.

Papers were also read at this session on "Wage Payment," by A. Z. DeLeeuw; "Systems for Mutual Control of Industry," by William L. Leiserson; and "What We May Expect of Profit Sharing in Industry," by Ralph E. Heilman. The discussion of these papers and of the general subject of the session was so prolonged that it was voted to hold an adjourned session in the afternoon so that full discussion might be allowed.

Thursday Afternoon Session

In the afternoon four simultaneous sessions were held. Three of these—Machine Design, Power Machinery and Textile—were regular scheduled sessions, while the fourth was the adjourned discussion from the morning session.

At the Machine Design session a paper on the "Reliability of Materials and Mechanism of Fractures" was read by M. Charles de Freminville, the newly elected honorary member of the society. The author called attention to the varying requirements for the properties of materials in different machines or parts of machines. He also described, briefly, methods of studying the behavior of materials by the examination of fractures.

A paper on "Tests on Dredging Pumps Used in Inner Harbor Navigation Canal, New Orleans," by W. J. White, described the design of a two-bladed pump impeller for hydraulic dredging, where this form of dredging had been rendered almost impossible by the great amount of roots and stumps encountered. The result of a number of tests was given to show the success of the new design.

W. J. White presented a paper on "Turbo-Compressor Calculations," in which he developed the mathematical formulas necessary for the design of turbo-compressors. Attention was called to the heating of the gas by friction, impact, etc., in addition to that which is due to the work of compression, and therefore to the increased necessity for cooling with this type of machine.

Two other papers were presented at this session: "A Perfected High-Pressure Rotary Compressor," by C. B. Lord, and "A New Type of Hydraulic Turbine Runner," by Forrest Nagler. Both will be published in abstract in *Power*.

At the Power Machinery session the following papers were presented: "Emergency Fleet Corporation Water-Tube Boilers for Wood Ships," by F. W. Dean and Henry Kreisinger; "Flow of Water Through Condenser Tubes," by William L. DeBaufre and Milton C. Stuart; "Air Pumps for Condensing Equipment," by Frank R. Wheeler; "Thermal Conductivity of Insulating Materials," by T. S. Taylor. The paper by Messrs. Dean and Kreisinger and that by Mr. Wheeler will be published in abstract in an early number of *Power*.

Flow of Water Through Condenser Tubes

In the paper on "Flow of Water Through Condenser Tubes" the authors give particulars regarding a series of tests recently conducted at the United States Naval Engineering Experiment Station, Annapolis, Md., to determine the friction loss of water flowing through ⅝-in., No. 18-gage standard condenser tubes. The investigations covered variable velocities, water temperatures and tube lengths as well as the effect of both fresh and salt water. A number of sections of 3-in. iron pipe were assembled with flanges. A corresponding number of lengths of ⅝-in. condenser tubing was obtained, and two brass blank

flanges were prepared to serve as tube sheets. These tube sheets could be inserted between any two pairs of flanges, thus enabling tube lengths of approximately 5, 8, 11, 14, 17 and 20 feet to be tested. The tubes were held in place by ordinary screwed glands and packed with cotton held between two fiber washers. The water was pumped by a centrifugal pump from a storage tank through a heater and then through the tube. From there it went to weighing tanks and then back to the storage tank. Temperature and pressure were noted at the entrance and exit to the tubes.

From the results obtained the following conclusions were reached:

The resistance with salt water was practically the same as with sea water.

The total resistance may be expressed by the formula, $P = 0.0118\ V^2 + 0.0051\ LV^{1.83}$ (when the average water temperature is 90 deg. F.), where

P = total pressure drop in pounds per square inch.

V = velocity in feet per second.

L = length of tube in feet.

The constants in this equation decrease as the average temperature decreases.

In answer to a question the author stated that no data were available as to the effect on entrance and exit losses when a number of tubes were together, as in ordinary condenser practice. The discussion brought out the fact that most manufacturers are now rounding the entrance to the ferrules to cut down such losses.

The experiments described in Mr. Taylor's paper were undertaken because of the lack of data regarding the thermal conductivity of such materials as are used in the construction of electrical machinery. The results obtained were tabulated for such materials as fish paper, fuller board, cambric, mica tape, various kinds of wood, sheet steel, etc. The results of the experiments may be summarized as follows:

By putting vaseline, glycerin, glue or similar material on the division between two surfaces the thermal drop due to such division may be largely eliminated.

Of the electrical insulating materials tested, those containing mica have in general the better thermal conductivity.

The transverse conductivity of iron stamping can be increased some three or four times by the insertion of some suitable material between the stampings so as to make better thermal contact.

A layer of dust, say coal dust, upon the surface of a body will increase its internal temperature.

The Textile Session

The Textile Section opened with a topical discussion of "Teaching and Training Textile-Mill Employees." Contributions were also presented on the "Mechanical Handling of Stock in Textile Mills." A paper on "Steam Use in Textile Processes," by George H. Perkins, called attention to the use of steam for processes as separate from that for power, and to the lack of technical attention which this subject has received. The various processes were classified in accordance with their use of steam and the factors affecting production and economy were listed. Results of tests were given to illustrate present common practice. In conclusion the author expressed the hope that his outline of the subject would stimulate greater attention to this matter and gave a list of suggestions as lines for study and research.

The session continuing the morning discussion of the Industrial Situation produced considerable written and oral discussion. At the end of the session a declaration of principles was adopted and referred to the Council of the Society. This declaration emphasized the public's interests in industrial questions and insisted that credit capital, which represents the productive ability of the community, should be administered with the sole view to the economy of productive power.

Thursday evening was devoted to entertainment and social matters rather than to professional subjects. Col. E. A. Deeds, Chief of Equipment Division of Air Service during the early development of the air program of the war, gave a lecture on "The Future of Aviation." Colonel Deeds predicted a great future for both military and commercial aviation, but warned against any promised thrills, as progress is bound to be slow, especially in the commercial field. His lecture was punctuated with humorous references to the "Battles of Washington," in which the I. W. W. or "Ink Well Warriors" took an important part.

Col. Thurman H. Bane, Chief of Engineering Division of Air Service and commanding officer of Cook Field, gave a lecture on "Present Development of the Military Airplane." Colonel Bane showed a number of lantern slides and moving pictures just released by the Government.

One of the most interesting of the films showed trials of bomb dropping at the Aberdeen proving grounds. The camera was carried on the plane directly above the bomb and the latter could be seen during its fall and explosion. At the same time the shadow of the machine could be seen on the ground, and the speaker explained that such pictures were used to trace the trajectory of the falling bomb.

Following the lectures the usual Thursday evening dance was held on the fifth floor of the building, while a social gathering and reunion for members and their guests took place on the first floor. This Thursday evening event has come to be looked on as one of the most enjoyable features of the annual meeting and this year's gathering proved no exception.

On Friday morning, Dec. 5, three simultaneous sessions were held under the titles, Transportation, Machine Shop and General.

At the Transportation Session the first paper was "The Scientific Development of the Steam Locomotive," by John E. Muhlfield. In this paper the author discusses at length the scientific factors that have been considered in the design and development of a new, high-powered freight locomotive for the purpose of substantially increasing the average thermal efficiency, as well as the maximum and sustained drawbar pull and horsepower per unit of weight, all of which are now limited by the capacity of the generally adopted boiler superheater.

A paper on "Motor-Transport Vehicles for the United States Army," by John Younger, discussed the types of vehicles best adapted to various military needs.

At the Machine Shop Session three formal papers were presented and an illustrated talk given on "Electric Arc Welding," the latter by H. L. Unland. A paper on "Common Errors in Designing and Machining Bearings," by C. H. Bierbaum, presented ten principles relating to journal bearings. Among these principles are the following:

The advance edge of a bearing surface must be chamfered off in order to permit a supporting film of oil to form.

The oil film forms best on a bearing surface whose advance edge is at right angles to the direction of motion.

Every unnecessary oil groove or interruption in the continuity of the oil film reduces its supporting capacity.

Another important point brought out was that bushings must be made so as to have room for expansion on heating. The author also emphasized the importance of sharp tools in machining bearing surfaces.

Other papers presented at this session were: "Lubrication of Ball Bearings," by H. R. Trotter, and "Thread Forms for Worms and Hobs," by B. F. Waterman.

At the General Session papers were read on "Slow-Speed and Other Tests of Kingsbury Thrust Bearings," by H. A. S. Howarth; "Octaval Notation and Measurement of Binary Inch Fractions," by Alfred Watkins; "Modern Electric Furnace Practice as Related to Foundries," by W. E. Moore; and "An Investigation of Strains in the Rolling of Metals," by Alfred Musso.

During the meeting various excursions were arranged for the members and their guests. Among these were inspection of a telephone exchange switchboard, a visit to the Seventy-fourth Street plant of the Interborough Rapid Transit Company, to the Equitable Building and power plant and to the Navy Yard in Brooklyn. The red-letter excursion was made Friday afternoon to the Curtiss Aëroplane Plant and Flying Field at Garden City, Long Island. Arrangements had been made whereby members could be taken on flights for a nominal sum. This feature proved very popular, for of about 200 who went to Garden City, 105 took advantage of the chance to fly.

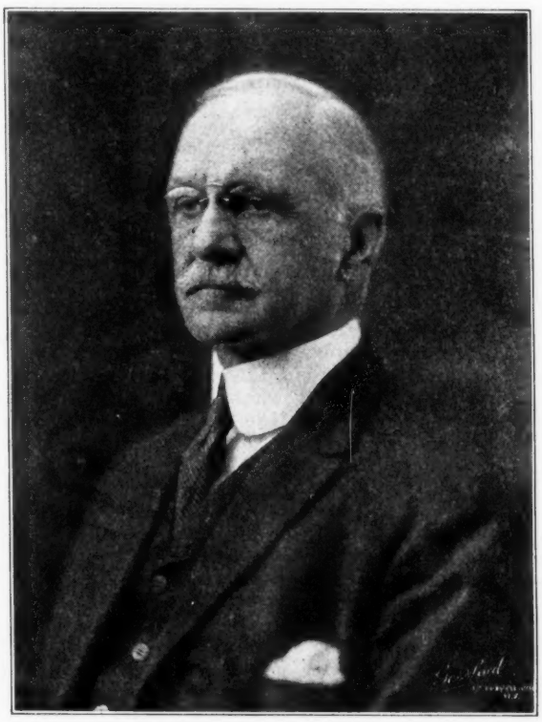
Friday evening reunions were held by representatives of the various colleges. This feature has become a regular event, although not part of the Society's official meeting.

The next general meeting of the Society will be the Spring Meeting, which is to be held May 24-27, 1920, at St. Louis, Mo.

Fred J. Miller

Mr. Fred J. Miller was elected president of the American Society of Mechanical Engineeers in connection with the annual meeting in New York, Dec. 2-5, 1919. In selecting Mr. Miller, the Society chose a man who has made an enviable record for himself along the lines of machine-shop and manufacturing practice, as well as in the field of engineering journalism.

Born in Ohio in 1857, he received a common and high school education, which he later supplemented by personal study and special instruction. Turning his attention to machine-shop work, Mr. Miller served a four years' apprenticeship at the machinist's trade, thus obtaining a thorough foundation for his later career in the manufacturing world. For a number of years he worked in various capacities in machine shops. During this time he was a frequent contributor to engineering journals, paying especial attention to articles on tool making.



FRED J. MILLER

In 1887 he left Ohio, where he was working as a tool maker, and came to New York City to become an associate editor of the *American Machinist*. He remained in this position until 1895, when on the retirement of F. F. Hemenway, Mr. Miller became editor in chief of the *Machinist*. This position he held until 1907. For a number of years he was vice-president of the publishing company.

After retiring from journalism, Mr. Miller became associated with the Union Typewriter Company, having charge of the manufacturing end of the business. In this position his thorough training as a machinist and a wide outlook acquired from his connection with journalism, proved its value in helping him to solve the number of manufacturing problems which arose.

When the United States declared war with Germany, Mr. Miller was asked by General Crozier, Chief of Ordnance, U. S. A., to accept a commission as a major in the Ordnance Department. During most of his service he was stationed at the Rock Island Arsenal, where he organized and was at the head of the Civilian Service Division of the Arsenal. Later, he was attached to the office of the Director of Arsenals in Washington, being assigned to duty at the Bethlehem Steel Works, and later still being attached to the office of the Secretary of War. Most of Major Miller's war work was in connection with the personnel in the Ordnance Department and with the settlement of labor troubles. One of his former associates, in speaking of his war activities, says: "It was one of those very important and difficult jobs that was well handled by a good man, but which, being of an unspectacular nature, got no applause for the man who performed it."

After leaving the Government service, Mr. Miller was associated with H. L. Gantt, up to the time of the latter's death in November of this year.

Mr. Miller has always taken a very active interest in the affairs of the American Society of Mechanical Engineers. He became a member of the Society in 1890, and was a member of the Council from 1904 to 1907. He saw service on a number of important committees, and has always taken an active interest in the welfare of the *Journal*, the monthly magazine of the Society which is now published under the title *Mechanical Engineering*. Owing to his long journalistic experience, Mr. Miller has been of considerable assistance in this direction. He served two terms as the Society's representative on the Board of the United Engineering Society and has been chairman of the committee of the Society having charge of the collection of data in regard to members' services for the Government during the war.

Investigation of Fatigue of Metals

An investigation of fatigue phenomena in metals under repeated stress has just been started under the joint auspices of the National Research Council, Engineering Foundation, and the Engineering Experiment Station of the University of Illinois. The Engineering Foundation is providing $15,000 a year for two years for this investigation, and the Engineering Division of the National Research Council is acting in an advisory capacity, largely through its committee on Fatigue Phenomena in Metals. The experimental work is being done in the laboratories of the engineering experiment station of the University of Illinois, under the immediate direction of Prof. H. F. Moore, Research Professor of Engineering Materials and chairman of the committee mentioned.

Plans are laid for a two years' program of tests, and apparatus and materials are already arriving for the tests. It is hoped to secure a considerable amount of data on tests of various metals, including a number of tests of each metal to 100,000,000 reversals of stress. It is hoped to study the various short-time physical tests which are used for metals, such as the impact test, magnetic analysis, and short-time bending tests, to see whether any of these give reliable indices of the ability of the metal to resist fatigue under millions of repetitions of low stress. It is hoped that some reliable commercial test for this important property may be developed by this investigation.

A test party of four or five persons is being organized, and the University of Illinois is fitting up a special laboratory with about 2500 sq.ft. of floor space for the use of this investigation.

National Power Program

"The first step in our power program," says George Otis Smith, the director of the Geological Survey, in his annual report to Congress, "is to get the facts for the country as a whole and particularly for the North Atlantic industrial district. At present, in the central power plants of the country," he says, "water power carries only about 40 per cent. of the load, while the total fuel requirement for steam generated power, including that of the railroads, is not less than 800,000 tons daily. A power program that calls for the immediate and full development of every available and feasible water power, moreover, means saving in both coal and land power, and with this purpose of securing the double conservation, the investigation has been proposed."

In regard to the North Atlantic industrial district project, he says: "Such a unified power system would tie together properly located steam-electric and hydro-electric plants—old plants that are efficient as well as new plants—in a great power main from which would flow the energy to serve a score of railroads, hundreds of public-service companies, thousands of mills and factories, and millions of homes."

Meeting of the American Society of Refrigerating Engineers

MONDAY, Dec. 1, President George E. Wells, of St. Louis, opened the 15th annual meeting of the American Society of Refrigerating Engineers in the Engineering Societies Building, New York. The morning was devoted to business and to an address by Charles Whiting Baker on the National Department of Public Works and National Service to Engineers. In his address President Wells laid particular emphasis upon the need of further developing the art of refrigeration to meet the increasing needs of industry. He recommended closer study of the work of other national engineering societies to the end that the conduct of the American Society of Refrigerating Engineers might be improved. One of the notes strongly sounded by President Wells was in reference to character building. "The important thing in life is not so much the work a man does as what he gets out of his work," said he.

This year's meeting was noteworthy for the number of papers on the properties of ammonia and brines by members of the technical staff of the United States Bureau of Standards. These were read at the Monday session and were as follows: "Specific Heats of Sodium-Chloride Solutions," by H. G. Barrett and G. S. Taylor; "The Preparation and Purification of Ammonia," by E. C. McKelvy and C. S. Taylor; "Pressure Gages for Precise Measurements up to 100 Atmospheres," by H. C. Dickinson and C. H. Meyers; "Vapor Pressures of Ammonia," by C. S. Cragoe, C. H. Meyers and C. S. Taylor; "The Specific Volumes of Saturated Ammonia in the Liquid and Vapor Phases," by C. S. Cragoe, E. C. McKelvy, D. R. Harper, 3rd, and G. F. O'Connor. These papers are not yet available for publication, having been retained by the authors who will make further studies before the bureau will release them. When it is fully realized how essential are better data on the properties of these substances, the import of the work the bureau is doing in this direction is appreciated. *Power* will publish abstracts of the papers as soon as they are available.

F. E. MATTHEWS

Tuesday morning the session opened with the following papers: "Refrigerator Cars and a System of Transit Refrigeration," by A. J. B. Harris, Chicago, Ill.; "Application of Flow Meters to Refrigerating Work," by H. D. Fisher, Boston; "The Packing House," by Joseph Himmelsbach, New York City.

Subscription luncheons were served in the building.

Dr. Mary E. Pennington opened the afternoon session with a paper on "Balsa Wood," a product of South American forests, used for insulation. The wood is extraordinarily light and, when treated, is quite fireproof. It must be treated immediately after being cut to avoid disintegration by rot. Considerable interest was shown in its cost as compared with other woods and insulators, but all efforts to get specific information from those connected with the paper were futile.

F. L. Fairbanks, Boston, described with the aid of about 100 lantern slides the new T-Wharf refrigerating plant of the Quincy Market Cold Storage Warehouse Co. This plant is fully described in *Power* for Oct. 28-Nov. 4, 1919.

There was no opportunity for further discussion that afternoon.

The dinner followed in the East Ballroom of the Astor in the evening. President Wells acted as toastmaster. Among the speakers were Peter Neff, one of the early presidents of the society, and Dr. Charles E. Lucke, head of the Department of Mechanical Engineering, Columbia University. Professor Lucke said he believed the art of refrigeration was due for an epochal advance. He is not sure but what it is already here in the form of the high-speed compressor electrically driven. It is a logical development, he says, to create electric transmission trunk lines from which much of the refrigerating machinery within the transmission zone may get its motive power. He was highly gratified with the improving coöperation between the physicist and the engineer as exemplified particularly in the papers at the Monday session by the staff of the National Bureau of Standards.

The attendance at the dinner and meeting was, it seemed, unusually large. There was excellent entertainment secured by Secretary Ross. Professor Neumann, the mind reader, performed astonishing feats, Lee Leland and Bobby Jones of the France Packing Co. sang, and Mr. Logan, for many years chief of entertainers at this function, was on hand.

Wednesday morning discussion of Mr. Fairbanks' plant was renewed, the chief participant being Professor Lucke. There followed a paper, "Present Situation of Refrigeration Industry in Russia," by N. Borodin, Russia. The time limit on the meeting room having expired, the two papers, "Conveying Machinery in the Refrigerating Industry," by Edwin McQueen, New York, and "Testing of Household Refrigerating Machines," by Henry L. Lincoln, Chicago, did not come up. The always valuable discussion which comes during the topical discussion of data was also laid over.

The meeting then went into joint session with the American Society of Mechanical Engineers in the Auditorium, where President Wells presented a paper on "Ice Plant Depreciation," and one on "Depreciation of Insulation" was presented by John E. Starr. At this session the American Society of Mechanical Engineers had six papers, all dealing with valuation and appraisal methods.

F. E. Matthews, well known to the readers of *Power*, is the new president of the American Society of Refrigerating Engineers. H. C. Gardener, of Chicago, was elected vice president, and Prof. Edward F. Miller, of the Massachusetts Institute of Technology, becomes first vice president. George A. Horne of New York was reëlected treasurer. The Council appoints the secretary, who is William Ross, widely known in refrigeration circles.

It is likely that the semiannual meeting of the society will be held with the Spring Meeting of the American Society of Mechanical Engineers, and possibly other national engineering societies will be present.

The *Electrical Review*, London, states that the new hydroelectric plant installed at the Kaubauk mine, Burma, India, is the first of its kind to be erected in the district. Kaubauk is about sixty miles from Tavoy Town, and the scheme is important because it provides the mining company with power for the successful exploitation of the deposits that exist in the Tavoy district. It also furnishes to the wolfram industry in particular, and to the province in general, an incentive to utilize the natural resources of Burma.

About three miles to the southward of Kaubauk and at the top of hills 3000 ft. high. is a natural horseshoe-shaped valley, across the heel of which a dam has been built, which impounds a reservoir that stores 500,000,000 gallons of water. Three miles of pipe line convey the water to the power house, built on the edge of the Kaubauk mine, the last portion of the pipe dropping nearly perpendicular 1800 ft., giving a head of 2094 ft. at the power house. The available energy is 1000 hp., only half of which is being utilized by the generator so far installed. The energy generated operates the machinery on a pump dredge which uses 400 hp., and is also used to drive the ore crushers

Practical Refrigerating Engineers Hold Convention at Kansas City

FROM Dec. 4 to 6 the National Association of Practical Refrigerating Engineers held its tenth annual convention at the Coates House, Kansas City, Mo. The recent restrictions due to the coal shortage interfered to some extent with the plans that had been made by the local committee, and reduced the attendance from that anticipated. Nevertheless the convention was a decided success, due primarily to the interest taken in the subjects presented, and the active participation in the discussion.

Kansas City had been given the convention to encourage the new subordinate recently organized there, this being the first step in a more active program of expansion. Another subordinate has been formed in Chicago, which will have the convention next year, and from now on organization work in various cities of the North and throughout the country will be pushed. It may be stated that the association is on a more substantial basis than ever before, and in its plans for expansion will have the active support and leadership of *Ice and Refrigeration*, which at the present convention was chosen as the official organ of the association.

After registration the first session was called Thursday morning, Dec. 4, with Vice-President J. E. Porter, of St. Louis, in the chair, E. P. Fryant, president of the association, having been unavoidably detained. Routine business, such as reading of the minutes of the last meeting, roll call of officers and appointments of committees, occupied the short period of time available.

In the afternoon four interesting papers were presented. "Refrigeration as Applied to the Manufacture of Ice Cream" was discussed by G. E. Kloss, who reviewed the early days of the industry, when refrigeration was obtained by the chemical action of salt, and traced the development up to the present day, when every large ice-cream manufacturer has a refrigerating plant of considerable proportions. The various refrigerating requirements in lowering the temperature of the milk, in holding, freezing and hardening the cream, were outlined by the speaker.

"Installation of Boilers for the Best Economy" was the subject allotted to J. E. Porter, who dwelt principally upon the construction of the setting and the requirements of a proper foundation. He emphasized the necessity of building the settings from drawings, rather than by verbal instructions. A valuable feature of the paper was the incorporation of data for estimating the quantities of materials needed. Discussion turned to the proper use of buck stays, and the danger of drawing them too tight, so that in the alternate heating and cooling they would tend to crack the setting. The speaker maintained that poor foundations, rather than buck stays, were more often the cause of setting failures. Steel settings, if properly insulated, were approved, but it was the consensus of opinion that brick settings could be made tighter and the radiation would be less.

In outlining what the engineer should do during the off season, Norman Register recommended, first, a durable memorandum book in which notes could be entered during the working season of things needing attention. The speaker outlined in some detail what these various things might be, and then with the list complete, suggested that the cost of the work and the saving that would be effected should be carefully estimated and presented to the manager in a conference called to decide what actually should be done. The discussion of the paper concentrated on methods of blowing oil from expansion coils. Blowing with steam first, and then with air, seemed to be the common practice. There were objections, however, to the internal use of steam and to avoid these, one of the speakers told how he had heated the coils from without with steam and then operated the ammonia compressor as an air compressor to blow out the oil. It was pointed out that the high-pressure end was the place to trap the oil, and with proper operation it should not get to the expansion coils. The small amount of oil that passes the oil traps should get into the liquid receiver, and by means of a regenerator could be removed. Owing to the danger of cracking the fittings, steam could not be used in cleaning double-pipe condensers. The only safe way was to take them down and swab out the pipes.

A paper by C. T. Baker, on the use of electricity in storage houses and ice plants, was read by the secretary, F. L. Brewer. The author strongly recommended the use of electricity in connection with storage houses. The control and operation were more simple. Long steam lines running to a steam engine, with the leakage, radiation and other prevailing troubles, were not to be considered. Owing to the absence of commutator and brush troubles a polyphase induction motor was the type of machine to use.

In the discussion it was brought out that the amount of power required to handle ice to and from storage ranged from 45 to 55 kw.-hr. per ton of ice. Other points discussed were calibration of meters, ammonia receiver capacity, and the equivalent values of oil versus coal as a fuel. A rough figure, commonly accepted, was 3 bbl. of 42 gal. each to a ton of average slack coal. One of the big advantages of using oil was the saving in labor that was possible. Another common figure, liberal in its allowances, was one ton of ice per barrel of oil, although in the discussion figures were given to show that a certain plant had produced a ton of ice on 27 gal. of oil.

Much of the session Friday morning was devoted to lubrication. A paper by C. W. Fryant outlined the usual methods of ordering oil, the prodigal use of cylinder oil, and the difficulty of distinguishing between oils that were approximately correct for the service. The burden of the paper was to trust a reliable salesman, representing a reputable house, to properly select the oil for the plant. In the discussion a single lubricator for the cylinders of all auxiliaries was considered. The oil being fed into a steam header common to the auxiliaries, rather than an individual feed to each machine, had in one case reduced the consumption by one-third. Equal distribution to all machines was questioned, but it was pointed out that if the oil was atomized and became thoroughly mixed with the steam, there would be no question about each ma-

NATIONAL ASSOCIATION OF PRACTICAL REFRIGERATING ENGINEERS IN CONVENTION AT KANSAS CITY

chine being lubricated; in fact the machine farthest away would probably receive better lubrication than the nearest, due to the greater amount of moisture in the steam at this point and the better lubrication that could be obtained with moist steam.

In the second paper on lubrication T. B. Phillipo called attention to the extreme temperatures in ammonia-compressor cylinders and the necessity of carefully selecting oil for cylinder lubrication. A straight mineral oil should be used possessing a flash point of 300 deg. F. or over, a cold test of zero or below, and for average operating condition, a body of 150 to 200 sec. of viscocity. One of the main causes of loss in a refrigerating plant was using an oil too light in body. Another cause of loss was placing the oil trap too near the compressor cylinders, so that part of the oil could be carried over in the form of vapor and not given the chance to cool and condense and be deposited in the oil trap. As to quantities of oil required, one quart of oil properly selected should lubricate 5,000,000 sq.ft. of surface swept over by the piston of the ammonia compressor. In the steam cylinders one quart of oil should lubricate 1,000,000 sq.ft. of cylinder surface traveled over by the piston. While the solidifying points of most oils was around 0 deg. F., in some cases it reached 15 deg. below zero, and reference was made to one oil having a solidifying temperature of 31 deg. below zero.

W. A. Converse of the Dearborn Chemical Co. gave an interesting talk on boiler-feed waters, their action and treatment. In a simple way the speaker reviewed the origin of water by evaporation, its formation in clouds, and how contamination first started as it fell through the atmosphere in the form of rain. The speaker then showed how the water assimilated farther impurities after it reached the earth and gave an outline of what these impurities were, dividing them into scale-forming and non-scale-forming ingredients. Typical cases were assumed, the quantity of scale-forming matter determined, and the effects of the non-scale-forming solids, such as sulphate of soda, chloride of soda, etc., by causing foaming and pitting, were reviewed. Various methods of treating the water were outlined. Emphasis was given to the necessity of making a chemical analysis of the water before treatment to determine what chemicals to use.

At the session Friday afternoon Bruce Dodson pointed out the relation of the engineer to plant-insurance costs. The condition of the plant, the layout, the selection of employees for the various duties, provision of safeguarding against accident, carelessness, ignorance, etc., all had an influence on the cost of insurance, and practically all of the items mentioned were under the influence of the engineer. Various good practices, tending to reduce the fire risk, were enumerated by the author, who appealed for co-operation along these lines. It would mean dollars and cents to the industry.

Following the paper was a discussion on raw-water ice. It was felt that the use of this system would increase, as it was necessary to make ice cheaper. With the raw-water system there was not much saving in labor, but a big saving in fuel, and it would eliminate the evaporating equipment. To remove some of the popular objections to raw-water ice, every precaution must be observed to make the blocks clear, one of the great difficulties being to get the employees to pull the drop pipes at the proper time.

Adding hot water from the boiler-feed supply to make up the distilled-water requirements was perfectly feasible if the water had been heated to a temperature exceeding 206 deg. F. Some of the engineers had sprayed this water into the exhaust pipe leading to the condenser, and by reboiling the condensate had obtained excellent results. The possibilities of operating a compression plant in conjunction with a low-pressure absorption system were given some consideration. The leading requirement was an abundance of cool water. Such a plant was cited in which plenty of water at 56 to 58 deg. was available. In this plant 11 tons of ice per ton of coal was produced, and the cost of maintenance was exceptionally low.

Friday evening there was a special lunch and entertainment, but the big feature of the convention, a turkey dinner, was reserved for Saturday afternoon. Saturday morning was devoted to minor changes in the constitution and a discussion on the unification of refrigerating interests. In brief, the plan is to form one composite group of all refrigerating interests, which shall represent the industry in national and international affairs, and have to do with the promotion of the interests of refrigeration in a broader way than can be done by any particular or local organization, a parallel being found in the Chamber of Commerce of the United States of America, as compared to the local chambers of commerce in individual cities. The convention passed a resolution indorsing the plan of unification, and co-operation in fulfillment of the idea. The board of directors was instructed to take steps to affiliate with the proposed centralized body, authority being given them to extend such financial support as the resources of the association would permit.

From a large field of applicants, Chicago was chosen as the next convention city, and the following officers for the ensuing year elected: President, G. E. Kloss, Kansas City; first vice president, C. E. Loker, Chicago; second vice president, J. E. Glenn, Anniston, Ala.; secretary, F. L. Brewer, Pilot Point, Tex.; treasurer, W. R. Ilch, Kansas City, Kan.; sergeant at arms, Eugene Gray, Ruston, Ala.

Personals

Capt. Joseph R. Greenwood, recently discharged from the U. S. Army, has renewed his association with the firm of Charles H. Higgins, architects and engineers.

H. W. Philbrook, formerly with the General Electric Co., Schenectady, N. Y., has been appointed district manager of the Schutte & Koerting Company's New York office, 50 Church St.

Joseph W. Roe, formerly assistant professor of mechanical engineering at Sheffield Scientific School, Yale University, New Haven, Conn., has been appointed secretary to Dr. W. F. M. Goss, president of the Railway Car Manufacturers' Association.

Fred W. Duemler, formerly connected with the Uniflow Boiler Co., Philadelphia, Penn., is now with The Bigelow Co., New Haven, Conn., as manager of sales in the Philadelphia, Pittsburgh and Chicago districts. New offices have also been opened at 515 Commercial Trust Building, Philadelphia.

Paul M. Lincoln, for many years commercial engineer of The Westinghouse Company, has resigned from that organization, effective Nov. 1, to enter the consulting engineering field, and in that capacity will have active charge of motor application engineering for the Lincoln Electric Co.

Prof. Auguste C. E. Rateau, of Paris, France, who represented the Académie des Sciences and the Société d' encouragement pour l' Industrie Nationale at the James Watt centenary held in Birmingham, England, last month, had the degree of Doctor of Law conferred upon him by the University of Birmingham.

Charles F. Scribner, formerly industrial engineer with the Colts' Patent Fire Arms Manufacturing Co., Hartford, Conn., and more recently consulting engineer for L. V. Estes, Inc., Chicago, has become associated with the Business Service Corporation of America, Chicago, Ill., in the capacity of vice president and chief engineer.

Engineering Affairs

The Engineering Council has been requested by the Associated General Contractors of America to appoint representatives to confer jointly with them and the American Institute of Architects in regard to the question of "Payment for Estimating." The council has appointed Samuel G. Neller of Chicago as one of three representatives. It is expected that the meeting will be held in Chicago some time in the near future.

The American Society of Mechanical Engineers, Ontario (Canada) Section, held its first meeting on Nov 14. It took the form of a dinner at the Engineers' Club, following which General C. H. Mitchell spoke on some phases of mechanical engineering in the war as observed by him in France and Italy. General Mitchell, who was Chief Intelligence Officer on the general staff of the British expedition sent to the aid of the Italians on the Piave, is dean of engineering at the University of Toronto. A monthly meeting of the section will be held hereafter.

Business Items

The Atlantic Sales Co. has organized as manufacturers' agents, with offices and warehouses at 59th St. and Woodland Ave., Philadelphia. M. F. Knapp and J. C. Vogel are the organizers of the firm.

The Black & Decker Manufacturing Co., Baltimore, Md., has moved its general offices from 105 So. Calvert St., Baltimore, to Towson Heights, Baltimore.

The Frederick Engineering Co. has become incorporated for the manufacture and sale of automatic stokers, steam jet ash conveyors and centrifugal pumps. The works are located at Frederick, Md., and the main office at 61 Broadway, New York City.

The Crocker-Wheeler Co., Ampere, N. J., has just inaugurated a plan of training for its foremen and other factory supervisors which is of considerable interest. A group of 62 men has been formed to pursue a three months' course in modern production methods, which comprises the study of specially prepared text units, the solution of problems relating to the units, and the discussion of this material at six biweekly meetings held after hours in the plant. These meetings will provide an opportunity to bring home the application of the work to the special problems of Crocker-Wheeler Co. production. At each meeting a lecture will be delivered by an experienced production man and the lectures will be followed by a round-table discussion. The course is under the direction of the Business Training Corp of New York City, which supplies the study material and the class instruction.

New Construction

PROPOSED CONSTRUCTION

Cal., Glendale—The City Trustees plan to hold another election to vote on $260,000 bonds to extend the water system and construct a power generating plant, and have sent out a statement advocating 2 wells, 2 pumps and a booster pump at San Fernando Rd. and Grand Ave., cost, $33,500; number of wells and pumps in Verdugo Canyon, $32,000; pumping plant at Grand View Ave. reservoir, $3000; electric generating plant with 100 kw. generator, driven by Pelton water wheel at Verdugo Canyon reservoir, $9700; also various other improvements.

Cal., Mare Island—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the installation of an electric light and power system at the Navy Yard, here. Estimated cost, $25,000.

Cal., San Diego—The U. S. Navy Department, Washington, D. C., is having plans prepared for the construction of a power house, in connection with the proposed hospital at Balboa Park, here. Total estimated cost, $2,000,000. F. W. Southworth, c/o Bureau of Yards & Docks, Washington, D. C., Engr.

Colo., Denver—T. H. Smith, 1520 Cleveland Pl., will soon award the contract for the installation of a heating system in the proposed 4 story, 75 x 150 ft. building on 13th Ave. and Broadway. Total estimated cost, $100,000. The Huntington Architect Co., 311 McPhee Bldg., Arch.

Conn., New Haven—Kusterer & Smith, 376 Yale Ave., is having plans prepared for the construction of a 6 story, 60 x 80 x 116 ft. business building, on Court St. A steam heating system will be installed in same. Total estimated cost, $100,000. Frank E. Brown, 11 Autumn St., Arch.

Conn., South Norwalk—H. Jacob & Sons, Belden Ave., Norwalk, is having plans prepared for the construction of a 5 story, 50 x 200 ft. factory, on State St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ia., Aurelia—The Board of Education, Consolidated District, is having plans prepared for the construction of a 3 story high school. A steam heating system will be installed in same. Total estimated cost, $165,000. W. Gordon, 319 Hubbell Bldg., Des Moines, Arch.

Ia., Corydon—A. T. Gallagher, City Clk., will soon award the contract for the construction of an earth dam, pumping station and filter plant. Total estimated cost, $50,000. M. G. Hall, City Engr.

Ia., Sioux City—The Auto Corporation, 201 Motor Mart St., is having plans prepared for the construction of a 3 story, 175 x 280 ft. tire factory. A steam heating system will be installed in same. Total estimated cost, $200,000. B. A. Rheinstrom, Mgr. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Engr.

Ia., Sioux City—The Scottish Rite Templars are having plans prepared for the construction of a 3 story, 140 x 255 ft. masonic temple on 12th St. A steam heating system will be installed in same. Total estimated cost, $750,000. Westcott Engineering Co., 111 Washington St., Chicago, Ill., Engr.

Ia., Woodbine—The School Board is having plans prepared for the construction of a 3 story school. A steam heating system will be installed in same. Total estimated cost, $100,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Arch.

Ill., Chicago—Ascher Brothers, 220 South State St., are having plans prepared for the construction of a 1 story, 90 x 90 ft. theatre on State St. near Randolph St. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Henry C. Newhouse, 4630 Prairie Ave., Arch.

Ill., Chicago—The Board of Trade had plans prepared for the construction of a 17 story, 125 x 125 ft. office building on Jackson and La Salle St. A steam heating system will be installed in same. Total estimated cost, $5,000,000. Holabird & Roche, 104 South Michigan Ave., Archs.

Ill., Chicago—The Cosmopolitan State Bank, 1159 North Clark St., is having plans prepared for the construction of a 1 story, 50 x 150 ft. bank on Chicago Ave. and Clark St. A steam heating system will be installed in same. Total estimated cost, $200,000. Schmidt, Garden & Martin, 104 South Michigan Ave., Arch.

Ill., Chicago—The Lincoln Ice Co., 317 North Elizabeth St., plans to construct a 4 story, 75 x 150 ft. ice plant, at 329 North Elizabeth St. A steam heating system and central power station will be installed in same. Total estimated cost, $100,000. Carl M. Almquist, 118 North La Salle St., Arch.

Ill., Chicago—Lubliner & Trinz, 25 East Jackson St., are having plans prepared for the construction of a 1 story, 170 x 225 ft. theatre, on Milwaukee and Sawyer Ave. A steam heating system will be installed in same. Total estimated cost, $900,000. W. W. Ahlschlager, 111 West Washington St., Arch.

Ill., Chicago—Schmidt, Garden & Martin, Archs., 104 South Michigan Ave., will soon award the contract for the construction of a 5 story, 125 x 500 ft. candy factory, on Franklin Blvd. and Homan Ave., for Bunte Brothers, 730 North Monroe St. Complete power and water plants will be installed in same. Total estimated cost, $1,500,000.

Kan., Coldwater—The city voted $35,000 bonds to improve the water and electric light plants. N. T. Baker, City Clk.

Kan., Hutchinson—The Columbia Realty & Amusement Co., c/o M. B. Shanberg, 1818 Grand Ave., Kansas City, Mo., plans to construct a 2 story, 50 x 150 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $100,000. F. C. McIlvain, Kansas City, Mo., Arch.

Kan., Wichita—J. L. Leland, Secy. of the Board of Education 1028 Hendryx St., will soon award the contract for the construction of a 3 story, 88 x 247 ft. school building. Steam heating and ventilating systems will be installed in same. Total estimated cost, $350,000. H. A. Noble, Kansas City, Engr. Lorentz Schmidt, 121 North Market St., Arch.

Mass., Fairhaven—The Atlas Storage Warehouse, Inc., 608 Pleasant St., New Bedford, plans to construct a 1 story, 75 x 200 ft. and a 3 story, 30 x 50 ft. refrigerating plant, here. Estimated cost, $100,000.

Mass., Willimansett (Holyoke P. O.)—The Stevens-Duryea Co., Chicopee Falls, will soon award the contract for the construction of a 1 story factory at Driving Park. A steam heating system and electric power system will be installed in same. Total estimated cost, $800,000.

Mich., Detroit—The Board of Education, 50 Broadway, will soon award the contract for the construction of a 2 story, 58 x 211 ft. school, with a 44 x 62 ft. wing, on Maplewood and Spokane Ave. A plenum heating system will be installed in same. Total estimated cost, $170,000. Malcolmson & Higginbotham, 404 Moffat Bldg., Archs.

Mich., Detroit—The Eastern Motor Sales Co., 404 Gratiot Ave., had plans prepared for the construction of a 3 story, 115 x 143 ft. service station on Gratiot Ave. A hot water heating sysem, boiler, pump and fan will be installed in same. Mildner & Eisen, 924 Hammond Bldg., Archs.

Mich., Detroit—Maurice H. Finkel, Arch., 303 Chamber of Commerce, will soon award the contract for the construction of a 2 story, 38 x 115 x 190 ft. theatre on Grand-River Ave. for H. C. Keywell, 501 Old Whitney Bldg. A steam heating boiler with forced ventilating equipment, etc., will be installed in same. Total estimated cost, $90,000.

Mich., Detroit—M. Kunstler, 394 Virginia Park, is having plans prepared for the construction of a 4 story, 50 x 90 ft. hotel on Adams Ave., E. A steam heating system will be installed in same. Total estimated cost, $150,000. A. D. Shank, 38 South Dearborn St., Chicago, Ill., Arch.

Mich., Detroit—The Western Gear Manufacturing Co., 1040 Scotten Ave., is having plans prepared for the construction of a 1 story, 40 x 86 ft. heat treating plant on Scotten Ave. Electric motors for power will be installed in same. Estimated cost, $30,000. Louis Scisorek, 225 Farwell Bldg., Arch. and Engr.

Mich., Detroit—M. A. Young, 754 Woodward Ave., is having plans prepared for the construction of a 3 story, 60 x 186 ft. sales and service building on Woodward Ave. and Brady St. A steam heating system will be installed in same. Total estimated cost, $125,000. Mildner & Eisen, 924 Hammond Bldg., Archs.

Mich., Grand Rapids—Kent County is having tentative plans prepared for the construction of a 2 story, 125 x 200 ft. juvenile home. A steam heating system will be installed in same. Total estimated cost, $150,000. Clark E. Higbee, County Bldg., Probate Judge. Osgood & Osgood, 8-10 Fulton St. E, Grand Rapids, Arch. and Engr.

Mich., Grand Rapids—The Trinity Methodist Episcopal Church is having plans prepared for the construction of a 2 story, 180 x 180 ft. church. A steam heating and forced ventilating system will be installed in same. Total estimated cost, $200,000. W. E. N. Hunter, 1306 Chamber of Commerce, Arch.

Minn., Chisholm—The city will soon award the contract for the construction of a 2 story, 250 x 300 ft. recreation building on West Lake Ave. A steam heating system will be installed in same. Total estimated cost, $375,000. Anthony Puck, Torrey Bldg., Duluth, Arch. and Engr.

Minn., St. Paul—Theodore Curtis, Curtis Hotel, Minneapolis, is having plans prepared for the construction of a 15 story, 200 x 350 ft. hotel, on Summit Ave. A steam heating system will be installed in same. Total estimated cost, $2,000,000. Long, Lamoreaux & Long, Andrus Bldg., Minneapolis, Arch.

Minn., St. Paul—C. H. Johnston, Arch., Capital Bank Bldg., will soon award the contract for installing a heating system in the proposed 2 story, 240 x 340 ft. business building at 10 South 4th St., for Gordon & Ferguson, 10 South 4th St. Total estimated cost, $150,000.

Minn., Waubun—The Board of Education is having plans prepared for the construction of a 2 story, 65 x 130 ft. high school building. Steam heating and fan ventilating systems will be installed in same. Total estimated cost, $100,000. Kirby T. Snyder, 933 Plymouth Bldg., Minneapolis, Arch. and Engr.

Mo., Columbia—The Boone County Hospital Board had plans prepared for the construction of a 3 story, 40 x 125 ft. hospital here. A steam heating system will be installed in same. Total estimated cost, $100,000. Farrar & Wiser, Kansas City, Mo., Arch.

Mo., St. Louis—The Union Electric Light & Power Co., 124 Locust St., will be in the market for machinery for new $7,000,000 power plant.

Mo., Washington—The city sold $5000 bonds to improve the waterworks system, including a deep well pump and other equipment.

Neb., Clay Center—The Board of Education is having plans prepared for the construction of a 2 story, 85 x 130 ft. high school. A steam heating system will be installed in same. Total estimated cost, $125,000. W. E. Hulse & Co., Hutchinson, Kan., Arch.

Neb., Guide Rock—The city voted $12,000 bonds to extend the electric light plant.

Neb., Lincoln—The Board of Education, 33 Bankers Life Bldg., will soon receive bids for the construction of a 3 story junior high school. A steam heating system will be installed in same. Total estimated cost, $600,000. Fiske & Meginnis, 33 Bankers Life Bldg., Arch.

Neb., Lincoln—The city plans an election to vote on $300,000 bonds to extend water and light plant. Plans include one 10,000,000 gallon pump, one 3000 k.w. turbo generator, one 500 h.p. boiler, etc. Burns & McDonnell, 400 Interstate Bldg., Kansas City, Mo., Consult. Engrs.

Neb., Norfolk—Armour & Co., 208 South La Salle St., Chicago, is having plans prepared for the construction of a 3 story poultry and cold storage plant here. Total estimated cost, $100,000.

Neb., Omaha—The Omaha Cold Storage Co., 801-13 Farnam St., plans to construct a 5 story, 126 x 154 ft. addition to its plant on 8th and Farnam St., to the Omaha Steel Works, 4802 Leavenworth. Total estimated cost, $250,000.

N. J., Asbury Park—A. Pryor, care of Mann & McNeille, Archs., 70 East 45th St., New York City, is having plans prepared for the construction of a theater and dance hall here. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. J., Bayonne—The city will soon award the contract for the installation of a centrifugal pump at Avenue B and West 56th St.

N. J., Elizabeth—J. A. Jackson, Arch. and Engr., 1123 Broadway, New York City, is preparing plans for the construction of a 3 story parochial school. A steam heating system will be installed in same. Total estimated cost, $125,000. Owner's name withheld.

N. Y., Brooklyn—Bailey's Department store, 502 Fulton St., plans to build a 10 story, 100 x 200 ft. store building at 302 Livingston St. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., Brooklyn—G. G. Cozine, care of R. T. Short, Arch., 370 Macon St., is having plans prepared for the construction of a 120 x 193 ft. theatre on Crescent and Fulton St. A steam heating system will be installed in same. Total estimated cost, $400,000.

N. Y., Brooklyn—Louis Gold, 44 Court St., will build a 4 story garage and service station on Atlantic Ave. between Franklin and Classon Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. Work will be done by day labor.

N. Y., Brooklyn—The Temple Shaari Torah, care of Kelly & McCarthy, Archs., 16 Court St., is having plans prepared for the construction of a 1 story, 50 x 100 ft. synagogue at 1607 Avenue R. A steam heating system will be installed in same. Total estimated cost, $175,000.

N. Y., Long Island City—G. Piel Co., 29 13th St., is having plans prepared for the construction of a 6 story, 150 x 200 ft. industrial building on 7th, 8th, Washington and Pierce Ave. A steam heating system will be installed in same. C. H. Higgins, 19 West 44th St., New York City, Engr. and Arch.

Ohio, Cleveland—The Cleveland Telephone Co. will receive bids about March 1 for the construction of a 4 story, 90 x 138 ft. exchange building on St. Clair Ave. and East 123rd St. A steam heating system will be installed in same. Power to be leased. Total estimated cost, $250,000. Allard Smith, Engineers Bldg., Mgr. A. N. Symes, 602 Engineers Bldg., Engr.

Ohio, Cleveland—The Cleveland Telephone Co. will receive bids about March 1 for the construction of a 3 story, 90 x 150 ft. exchange building on West 65th St. and Guthrie Ave. A steam heating system will be installed in same. Power to be leased. Total estimated cost, $200,000. Allard & Smith, Engineers Bldg., Mgr. A. N. Symes, 602 Engineers Bldg., Engr.

Ohio, Bellevue—The Collier Motor Truck Co. is having plans prepared for the construction of a 1 story, 60 x 90 ft. assembly plant here. A steam heating system will be installed in same. Total estimated cost, $100,000. E. McGeorge, 1900 Euclid Ave., Cleveland, Arch.

Okla., Broken Bow—The city plans to construct a new electric light plant. Estimated cost, $135,000. Hughes Engineering Co., 304 Bank of Commerce Bldg., Tulsa, Engr.

Okla., Duncan—Stephens County has had plans prepared for the construction of a 3 story, 70 x 84 ft. courthouse on Main St. A steam heating system will be installed in same. Total estimated cost, $150,000. Jewel Hicks, Oklahoma City, Arch.

Okla., Hobart—The City Council has accepted the preliminary report prepared by V. V. Long, Engr., 1300 Colcord Bldg., Oklahoma, for the construction of a dam, 14 inch gravity flow line and pumping station. Total estimated cost, $120,000.

Ore., Wallowa—The Enterprise Electric Co., Spokane, Wash., plans to install a 225 h. p. Pelton wheel and 35,000 lbs. piping for the extension of the light and power facilities here. Estimated cost, $5000. B. Serier, Mgr.

Pa., Allentown—Max Spiegel, Strand Theater Bdg., New York City, is having preliminary plans prepared for the construction of a theater. A steam heating system will be installed in same. Total estimated cost, $250,000. David Levy, 949 Hamilton Ave., Engr. and Arch.

Pa., Oil City—The Columbia Realty Co., Erie, plans to build a theater. A steam heating system will be installed in same. Total estimated cost, $200,000. Arland W. Johnson, 24 East 42nd St., New York City, Engr.

Pa., Philadelphia—The Atlantic Refining Co., 3144 Passyunk St., is having plans prepared for the construction of a 20 story, 80 x 120 ft. office building on Broad and Spruce Sts. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Cass Gilbert, 244 Madison Ave., New York City, Arch and Engr.

Wis., Kenosha—The Frost Manufacturing Co. plans to install its own power plant during the year.

Contracts Awarded

Mich., Detroit—J. McE. Bowman, Hotel Biltmore, New York City, has awarded the contract for the construction of a 23 story, 120 x 255 ft. hotel on Madison Ave. here to George A. Fuller, Penobscot Bldg. A steam heating system will be installed in same. Total estimated cost, $5,000,000.

Mich., Detroit—The Detroit Edison Co., David Whitney Bldg., has awarded the contract for the construction of a 2 story, 25 x 113 ft. electric sub-station on Connor's Creek Rd. near Six Mile Rd. to Albert A. Albrecht, 1130 Penobscot Bldg. Estimated cost, $50,000. Noted Sept. 16.

Mich., Detroit—The Gray Estate, Hammond Bldg., has awarded the contract for the construction of a 2 story, 140 x 189 ft. garage and sales room on Antoinette and Cass Aves. to Frank H. Davies, Penobscot Bldg. Steam heating equipment, consisting of boiler, air compressor, fan, etc., will be installed in same. Total estimated cost, $150,000.

Mich., Detroit—The La Salle Garden Theater Co., c/o C. W. Brandt, Arch., 1113 Kresge Bldg., has awarded the contract for the construction of a 2 story, 106 x 124 ft. theater on 14th Ave., Ferry Park, to Frank Farrington Co., 201 Scherer Bldg. Total estimated cost, $150,000. Steam heating equipment, consisting of a boiler with air washer, motor-driven fans, etc., will be installed in same.

Mich., Detroit—The C. R. Wilson Body Co., Clay Ave., has awarded the contract for the construction of a 2 story, 45 x 100 ft. power house on Clay Ave., to A. A. Albrecht Co., 1130 Penobscot Bldg.

Minn., Minneapolis—The Wallis Coach & Carriage Co., 12 East Grand St., St. Paul, has awarded the contract for the construction of a 4 story, 84 x 155 ft. coach factory on University and Bedford Ave. to Foley Brothers, Gilfillan Bldg., St. Paul. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mo., St. Louis—The Polar Wave Ice & Fuel Co., 3620 Olive St., has awarded the contract for the construction of a 1 story, 47 x 101 ft. ice factory at 1931-35 Vanderventer St. to the Fruin Colnon Contracting Co., Merchants' Laclede Bldg. Estimated cost, $20,000.

Mo., St. Louis—The Scullen Steel Co., 6900 Manchester Ave., has awarded the contract for the construction of three 1 story rolling mills on Manchester Ave. to the Fruin Colnon Contracting Co., Merchants' Laclede Bldg. A steam heating system will be installed in same. Total estimated cost, $200,000.

Mont., Billings—The Crystal Ice & Fuel Co., 15 North 22nd St., has awarded the contract for the construction of a 1 story, cold storage building to Frank Jacoby & Son, 1041½ North 3rd St. Estimated cost, $50,000.

Neb., Omaha—Farrell & Co., 10th and Dodge St., has awarded the contract for the construction of a 6 story, 60 x 106 ft. factory for the manufacture of syrup and cans on the northwest corner of 9th and Dodge Sts. to Peter Kiewit & Sons, 754-56 Omaha National Bank Bldg. A high pressure steam heating system will be installed in same. Total estimated cost, $200,000.

N. J., Edgewater—The U. S. Aluminum Co. has awarded the contract for the construction of an 81 x 450 ft. and an 80 x 176 ft. steel factory to the Turner Construction Co., 244 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

N. Y., Brooklyn—Marcus Loew, 1492 Broadway, New York City, has awarded the contract for the construction of a theater on Bay Ridge Ave. and 5th St. to Louis Gold, 44 Court St. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., Greycourt—The Superintendent of the Department of Correction, Municipal Bldg., New York City, has awarded the contract for the installation and completion of the boilers and high pressure piping in the administration building at Greycourt House, to J. Dames & Co., Inc., 1996 Nostrand Ave., Brooklyn. Estimated cost, $10,000.

Ohio, Cleveland—The Auto Carriage Co., West 9th St., has awarded the contract for the construction of a 3 story, 60 x 400 ft. factory on Bedford Ave. to H. K. Ferguson Co., 6523 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—L. Israel, 743 East 91st St., has awarded the contract for the construction of a 3 story, 100 x 198 ft. store, theater and office building on Euclid Blvd. to the Kinsman Builders Supply Co., East 79th St. and Kinsman Rd. A steam heating plant will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The Manufacturers Oil & Grease Co., Century Bldg., has awarded the contract for the construction of a 2 story, 78 x 83 ft. factory to the Watson Engineering Co., 1101 Hippodrome Bldg. A boiler plant will be installed in same. Total estimated cost, $75,000.

Ohio, Cleveland—The Monarch Brass Co., 4613 Payne Ave., has awarded the contract for the construction of a 2 story, 66 x 200 ft. factory on 45th St. and Payne Ave. to the Emerson Co., 1900 Euclid Bldg. A steam heating system will be installed in same. Total estimated cost, $150,000. A. S. Dentsch, Pres.

Pa., Allentown—The International Motor Co., 2302 Chestnut St., has awarded the contract for the construction of a 2 story, 60 x 300 ft. and a 1 story, 300 x 540 ft. factory buildings to the Austin Co., Bulletin Bldg., Philadelphia. A steam heating system will be installed in same. Total estimated cost, $300,000.

Pa., Philadelphia—Folwell Brothers & Co., Inc., 625 Chestnut St., has awarded the contract for the construction of a 5 story, 23 x 101 ft. factory on American and Somerset Aves. to W. Steele & Sons Co., 16th and Arch Sts. A steam heating system will be installed in same. Total estimated cost, $400,000.

Pa., Philadelphia—The Philadelphia Electric Co., 10th and Chestnut St., has awarded the contract for the construction of a 5 story, 150 x 300 ft. power house on Beach and Palmer St., to Stone & Webster, Medical Arts Bldg. A steam heating system will be installed in same.

R. I., Pawtucket—The Jenckes Spinning Co., Weeden St., has awarded the contract for the construction of a 3 story, 48 x 104 ft. and a 4 story, 114 x 174 ft. mill addition to the Willworth Mackillop, Inc., Freeman St. A steam heating system will be installed in same. Total estimated cost, $250,000.

S. C., Wareshoals—The Wareshoals Manufacturing Co. plans to construct a 100 x 125 ft. ice plant. J. E. Sirrine, Greenville, Engr. and Arch.

S. D., Madison—Robert S. Westaby, c/o P. O. Moe, Arch., 616 New York Life Bldg., Minneapolis, has awarded the contract for the installation of a heating system in the proposed hospital here, to the Fitzgerald Heating Co., Madison. Estimated cost, $9000.

Va., Richmond—The Long Ice & Coal Co. plans to construct an ice plant on Brook Rd. Estimated cost, $100,000. Address M. A. Massie, 723 American National Bank Bldg.

Wis., Milwaukee—Hummel & Downing Co., North Cambridge Ave., has awarded the contract for the construction of a 7 story, 100 x 120 ft. warehouse to the Hansen Construction Co., 425 East Water St. A steam heating system will be installed in same. Total estimated cost, $300,000.

Wis., Milwaukee—The Pabst Brewing Co., 9th and Chester Sts., has awarded the contract for the construction of a 5 story, 85 x 210 ft. factory on Chestnut St. to L. J. Voell, 504 40th St. A steam heating system will be installed in same. Total estimated cost, $125,000.

Okla., Elk City—The Board of Education has awarded the contract for the construction of a 2 story, 60 x 195 ft. high school with 2 wings to the Kreipke-Schafer Construction Co., Oklahoma City. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ont., Toronto—The Dominion Bank, Dominion Bank Bldg., has awarded the contract for the construction of a 2, 3 and 4 story, 85 x 93 ft. bank building on Queen and Bay Sts., to Witchall & Son, 156 St. Helens St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ont., Walkerville—The Peabody Sales Corporation, Ltd., Windsor, has awarded the contract for the construction of two factory additions, 4 story, 80 x 250 ft., and 4 story, 60 x 200 ft., to Wells & Gray, Confederation Life Bldg., Toronto. Present heating system will be extended. Total estimated cost, $500,000.